CRUISE REPORT

C-103

**Scientific Activities**

**Undertaken Aboard**

**SSV *Corwith Cramer***

St. Thomas - Bequia - Tobago Cays - Bonaire - Roatan - Miami

1 December, 1988 - 11 January, 1989

**Sea Education Association**
**Woods Hole, Massachusetts**

"Reeling up from great depths is a long and great labor. It takes half a day to put together and rig the machine and it is a dangerous business with any motion of the ship."

Lieutenant J.C. Walsh, Schooner *Taney*, 1849

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## 1 Preface

This cruise report outlines the scientific research and academic program conducted on board SSV *Corwith Cramer* during her fourth cruise during the winter of 1988-1989. It consists of the abstracts of the student projects completed during this cruise and the data which are being incorporated into the long-term studies of the SEA staff and associated researchers. The bulk of this report was written at sea and is not intended to represent a final analysis or interpretation of data generated during C-103.

C-103, the Christmas Trip, was *Cramer*'s first venture into the southern Caribbean. C-103 was perhaps the most challenging of all Sea Semesters for the science sampling program. Despite sometimes heroic efforts, the main hydro-winch was inoperative for the entire cruise, resulting in drastic changes to the sampling program and several of the student research projects. All aboard the *Cramer* accepted this setback and made ingenious contributions toward the successful completion of the scientific mission of the ship. I am sure that it has been many, many years since oceanographic sampling gear, including rock dredges, a Shipek Grab sampler and the infamous gravity core, have been deployed on a line hauled back by hand. My thanks to all who were a part of the human hydro-winch. It was an experience I will probably never forget, even if I do not wish to repeat it. This willingness to try new ideas and cooperate exemplified the spirit of C-103. The large number of samples, including a particularly complete surface data-set, collected in a consistent pattern during C-103, provided an extensive pool of data for the completion of all student projects and made a significant contribution to the long term research of SEA. It was a real pleasure to have been been a member of the scientific staff of C-103.

The weather during this trip contrasted directly with the behavior of the winch. Calm seas and fair winds prevailed throughout the six weeks of this passage. Sampling operations were interrupted on only two days, during each of which the *Cramer* made close to 200 miles, providing us with an extended opportunity to conduct shallow bank top studies. The first leg, St. Thomas to Bequia and the Tobago Cays, introduced us to the pleasures of sailing in the Caribbean. Clear, sunny days and calm seas permitted intensive surface sampling in support of projects investigating the island mass effect. Tobago Cays, a small group of beautiful and unspoiled islands, were the site of several island and coral reef studies. The passage to Bonaire was highlighted by a brief meeting and sail with classmates aboard *Westward*. Our stay on Bonaire permitted the continuation of several of the island-based projects and gave all aboard a deserved rest. Pink flamingos and wave-cut terraces were both observed during field geological trips around the island. *Cramer* encountered her only days of rough weather on leaving Bonaire, and responded with skillful sailing, making time and miles which allowed a thorough sampling program on Pedro Bank. This shallow bank top, south of Jamaica, was the location of the now traditional Christmas Day gala rock dredging revelry and the debut and deployment of the notorious gravity core. New Year's Eve was celebrated in Port Royal, Roatan, where the hydro-winch was finally put to some good use, while everyday at-sea routine, including boat checks, was maintained. The staff stepped into the background as *Cramer* departed from Roatan. Student JWOs and JSWOs capably ran deck and lab operations. Beautiful sailing conditions continued as we tacked through the Yucatan Straits toward Miami and the completion of the cruise.

The success of C-103 was due to the efforts of the staff of *Corwith Cramer*. The nautical staff was directed by Captain Phil Sacks. Phil guided the ship with a sure hand and was a constant inspiration for updating and improving operations throughout the ship. The design and construction of the "anthro-winch" was perhaps Phil's most dramatic contribution. First mate Doug Nemeth provided both formal instruction in Nautical Science and a constant example of professionalism on deck at all times. Second Mate and Bosun Kevin Eley brought a wealth of experience on both large and small, but fast, sailing ships. Third Mate Wendy Runstadler directed her watch with enthusiasm and a great sense of humor.

Steward Albert "Flash" Shahinian produced delicious and beautifully prepared meals in the spacious *Cramer* galley. Christmas dinner and the re-configuration of the hydro-winch on New Years Eve were true high points of the voyage.

Ken Potter, engineer, struggled mightily with the electronic complexities of the ailing winch, both during the cruise and in the week before. Ken never did give up on the winch, and someday, somewhere, maybe even before the beginning of the next cruise, will have it running the way its makers tell us it will.

The science staff, Sarah Griscom, Amy Friedlander and Karen Wilson directed lab operations with authority and a true enthusiasm for science at sea. Karen, on her first trip as scientist, provided thorough instruction and oversaw the always popular Creature Features. Amy, also on her first SEA cruise, quickly learned lab operations and made a large contribution to the scientific operations of the ship with her knowledge of physical oceanography. Sarah oversaw the lab, maintained the equipment, and perhaps most importantly, helped all aboard *Cramer* preserve a sense of humor throughout the cruise.

Visitors Tim Kenna and Chuck Holloway were a tremendous help to both science and deck during the first leg of the cruise. Chuck's expedition, chaperoning the winch motor from St. Thomas to motor doctors in Virginia and back, via San Juan, has already entered the annals of great SEA adventure stories. Tim removed and replaced wires on the expiring winch more times than any human being should, and proved invaluable in operating the ship's generator. Both Tim and Chuck inspired the transformation of many ship's bits and pieces into Secret Santa Christmas gifts. Marcel Grashof, Assistant Director of the Marcultura Foundation on Bonaire, acting as a scientific observer from the Netherlands Antilles, quickly became a valued member of the ship. Marcel observed and assisted all operations of the ship with enthusiasm, and gave several lectures, complete with slide shows on the main sail, of marine research in the Netherlands Antilles.

While the cruise would not have been successful or even possible without the efforts of the staff, it was the twenty students of C-103 who did the work and produced the data enclosed in this report, often despite every obstacle provided by the sea and the wearing 24-hour operating schedule of the ship. I was continually impressed with the quality of work enthusiastically performed by the students, their excitement as the ocean unfolded around us, and their continuing dedication to producing work of real value. For all the staff, I thank the students of C-103. Each of you helped to make this a memorable cruise.

Paul Joyce
Chief Scientist, C-103

# 2 Introduction

## 2.1 Research Program

This cruise report is the written record of the scientific program conducted during the one hundred third Sea Semester aboard the SSV *Corwith Cramer*. The cruise track (Fig. 1) was designed to permit collection of physical, chemical, biological and geological data from several distinct oceanographic areas in the Caribbean Sea.

The research program was centered around the individual student research projects designed during the six-week shore component immediately prior to C-103. These projects were designed to focus on a specific biological, chemical, physical or geological oceanographic problem. On-board project expansions and inter-project cooperations were common and demonstrate the interdisciplinary nature of *Corwith Cramer's* research. Abstracts of the student research projects are included in section 3.

The variety and extent of information collected and analyzed during C-103 is only touched on in these abstracts of the student reports. The appendices present a more complete idea of the rich texture of oceanographic data compiled during this cruise.

Research conducted during this cruise represents, in part, the ongoing work of individuals and agencies that have extended assistance to our students. Materials reported herein should not be excerpted or cited without the written permission of the Chief Scientist.

**Figure 1 - Cruise Track of SSV *Corwith Cramer* Cruise C-103**

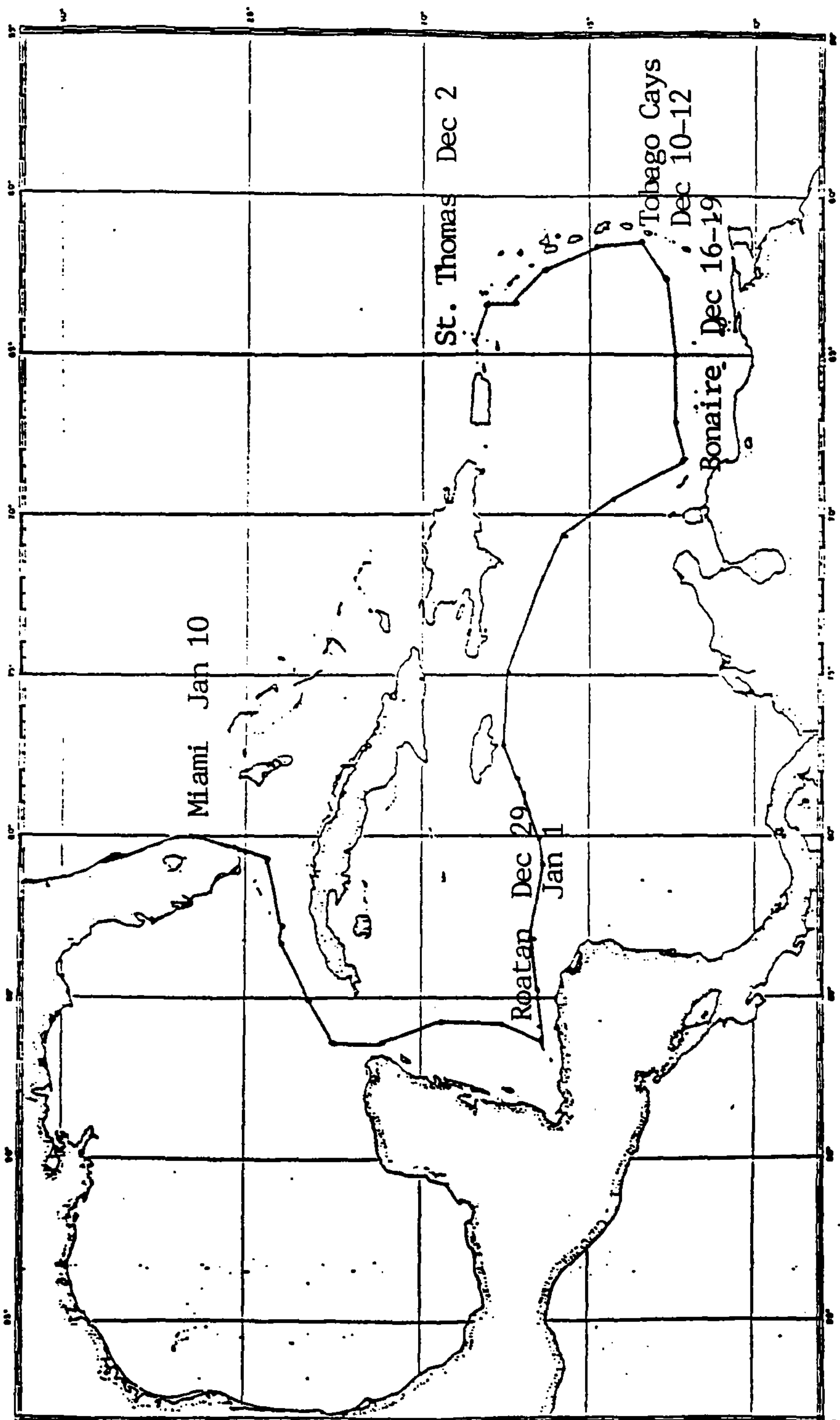

Table 1 - Daily Noon and Midnight Positions. SSV *Corwith Cramer*, Cruise C-103

| Date | Time | Log, (nm.) | Latitude N. | Longitude W. |
|---|---|---|---|---|
| 02-Dec-88 | 1200 | | alongside | Charlotte Amalie |
| 03-Dec-88 | 0000 | 13.3 | 18°13 | 64°55 |
| 03-Dec-88 | 1200 | 41.7 | at anchor: | Charlotte Amalie |
| 04-Dec-88 | 0000 | 108.5 | 17°59 | 63°58 |
| 04-Dec-88 | 1200 | 147.8 | 17°39 | 63°29 |
| 05-Dec-88 | 0000 | 179.5 | 17°08 | 63°35 |
| 05-Dec-88 | 1200 | 221.5 | 16°27 | 63°14 |
| 06-Dec-88 | 0000 | 287.0 | 16°07 | 62°15 |
| 06-Dec-88 | 1200 | 356.8 | 15°51 | 62°13 |
| 07-Dec-88 | 0000 | 359.2 | 15°07 | 61°46 |
| 07-Dec-88 | 1200 | 393.7 | 14°33 | 61°33 |
| 08-Dec-88 | 0000 | 443.2 | 13°46 | 61°28 |
| 08-Dec-88 | 1200 | 481.0 | 13°12 | 61°25 |
| 09-Dec-88 | 0000 | 514.5 | 13°01 | 61°18 |
| 09-Dec-88 | 1200 | 517.6 | at anchor: | Bequia |
| 10-Dec-88 | 0000 | 517.6 | at anchor: | Bequia |
| 10-Dec-88 | 1200 | 543.8 | at anchor: | Tobago Cays |
| 11-Dec-88 | 0000 | 543.8 | at anchor: | Tobago Cays |
| 11-Dec-88 | 1200 | 543.8 | at anchor: | Tobago Cays |
| 12-Dec-88 | 0000 | 543.8 | at anchor: | Tobago Cays |
| 12-Dec-88 | 1200 | 543.8 | at anchor: | Tobago Cays |
| 13-Dec-88 | 0000 | 582.8 | 12°41 | 62°00 |
| 13-Dec-88 | 1200 | 646.0 | 12°37 | 63°03 |
| 14-Dec-88 | 0000 | 700.5 | 12°21 | 63°50 |
| 14-Dec-88 | 1200 | 756.0 | 12°22 | 64°54 |
| 15-Dec-88 | 0000 | 804.0 | 12°32 | 66°07 |
| 15-Dec-88 | 1200 | 869.3 | 12°39 | 67°03 |
| 16-Dec-88 | 0000 | 928.0 | 12°00 | 68°14 |
| 16-Dec-88 | 1200 | 961.8 | alongside: | Bonaire |
| 17-Dec-88 | 0000 | 961.8 | alongside: | Bonaire |
| 17-Dec-88 | 1200 | 961.8 | alongside: | Bonaire |
| 18-Dec-88 | 0000 | 961.8 | alongside: | Bonaire |
| 18-Dec-88 | 1200 | 961.8 | alongside: | Bonaire |
| 19-Dec-88 | 0000 | 961.8 | alongside: | Bonaire |
| 19-Dec-88 | 1200 | 961.8 | alongside: | Bonaire |
| 20-Dec-88 | 0000 | 102.8 | 13°03 | 68°38 |
| 20-Dec-88 | 1200 | 1097.7 | 14°13 | 69°38 |
| 21-Dec-88 | 0000 | 1191.9 | 15°38 | 70°41 |
| 21-Dec-88 | 1200 | 1282.1 | 16°17 | 72°16 |
| 22-Dec-88 | 0000 | 1363.6 | 16°59 | 73°55 |
| 22-Dec-88 | 1200 | 1426.9 | 17°21 | 74°52 |
| 23-Dec-88 | 0000 | 1493.6 | 17°23 | 76°17 |
| 23-Dec-88 | 1200 | 1553.5 | 17°34 | 77°10 |
| 24-Dec-88 | 0000 | 1596.7 | 17°10 | 77°51 |
| 24-Dec-88 | 1200 | 1615.7 | 17°00 | 78°22 |

| | | | | |
|---|---|---|---|---|
| 25-Dec-88 | 0000 | 1664.4 | 16°50 | 79°07 |
| 25-Dec-88 | 1200 | 1714.2 | 16°33 | 80°06 |
| 26-Dec-88 | 0000 | 1729.1 | 16°23 | 80°26 |
| 26-Dec-88 | 1200 | 1741.3 | 16°21 | 80°57 |
| 27-Dec-88 | 0000 | 1815.2 | 16°33 | 82°29 |
| 27-Dec-88 | 1200 | 1869.9 | 16°41 | 83°28 |
| 28-Dec-88 | 0000 | 1919.3 | 19°19 | 84°21 |
| 28-Dec-88 | 1200 | 1968.3 | 16°28 | 84°49 |
| 29-Dec-88 | 0000 | 2018.7 | 16°19 | 85°47 |
| 29-Dec-88 | 1200 | 2050.3 | at anchor: | Roatan |
| 30-Dec-88 | 0000 | 2050.3 | at anchor: | Roatan |
| 30-Dec-88 | 1200 | 2050.3 | at anchor: | Roatan |
| 31-Dec-88 | 0000 | 2050.3 | at anchor: | Roatan |
| 31-Dec-88 | 1200 | 2050.3 | at anchor: | Roatan |
| 01-Jan-89 | 0000 | 2050.3 | at anchor: | Roatan |
| 01-Jan-89 | 1200 | 2050.3 | at anchor: | Roatan |
| 02-Jan-89 | 0000 | 2087.6 | 16°40 | 85°57 |
| 02-Jan-89 | 1200 | 2137.0 | 17°37 | 85°54 |
| 03-Jan-89 | 0000 | 2177.3 | 18°15 | 86°20 |
| 03-Jan-89 | 1200 | 2252.1 | 19°26 | 86°03 |
| 04-Jan-89 | 0000 | 2304.2 | 20°27 | 86°20 |
| 04-Jan-89 | 1200 | 2114.3 | 21°14 | 86°16 |
| 05-Jan-89 | 0000 | 2409.0 | 21°53 | 85°41 |
| 05-Jan-89 | 1200 | 2451.7 | 22°79 | 86°14 |
| 06-Jan-89 | 0000 | 2510.0 | 23°03 | 85°52 |
| 06-Jan-89 | 1200 | 2583.0 | 23°07 | 85°02 |
| 07-Jan-89 | 0000 | 2607.9 | 23°53 | 83°58 |
| 07-Jan-89 | 1200 | 2666.7 | 24°06 | 83°28 |
| 08-Jan-89 | 0000 | 2739.3 | 23°34 | 83°09 |
| 08-Jan-89 | 1200 | 2799.6 | 24°03 | 82°20 |
| 09-Jan-89 | 0000 | 2867.4 | 24°11 | 81°34 |
| 09-Jan-89 | 1200 | 2930.0 | 24°13 | 80°51 |
| 10-Jan-89 | 0000 | 2989.0 | 24°35 | 80°20 |
| 10-Jan-89 | 1200 | 3020.2 | alongside: | Miami, FL |

**Table 2. - Ship's Complement for SSV *Corwith Cramer* Cruise C-103**

Nautical Staff

| | |
|---|---|
| Phil Sacks | Captain |
| Doug Nemeth | First Mate |
| Kevin Eley | Second Mate |
| Wendy Runstadler | Third Mate |
| Ken Potter | Engineer |
| Albert Shahinian | Steward |

Scientific Staff

| | |
|---|---|
| Paul Joyce | Chief Scientist |
| Sarah Griscom | First Scientist |
| Amy Friedlander | Second Scientist |
| Karen Wilson | Third Scientist |

Visitors

| | |
|---|---|
| Chuck "Indiana" Holloway | |
| Tim "Juan" Kenna | |
| Marcel Grashof | Marcultura Foundation, Bonaire |
| Catherine Holloway | |

Visiting Alumni

Bruce Dugan
Michael Wright
Melissa Dick
Thomas Kadala
Melanie Wilson

Students

| | |
|---|---|
| Norman Allegar | Princeton University |
| Joshua Belsky | St. Lawrence University |
| Timothy K. Biglelow | Castleton College |
| Randa Chehab | Smith College |
| Christa Daly | Mt. Holyoke College |
| Eileen D. Early | Boston College |
| Christopher D. Edgar | University of Rhode Island |
| Marci B. Glazer | Harvard College |
| Alexander vR. Gryska | University of Rhode Island |
| Steven F. Hilger | St. Lawrence University |
| Jeffrey A. Lawson | Hampden Sydney College |
| Patrick M. Liu | Cornell University |
| Susan McCarthy | St. Lawrence University |
| David Neuman | Cornell University |
| Carolyn H. Nichols | Wheaton College |

| | |
|---|---|
| Louis T. Nosce | Brown University |
| Teryl K. Nuckols | Cornell University |
| Pauline Power | University College Galway |
| Matthew C. Samuelson | Bowdoin College |
| Laura M. Taylor | Trinity College |

## 2.2 Academic Program

A 24-hour science watch was maintained throughout the six week period of SSV *Corwith Cramer* C-103. These watches were maintained by teams of three students and one member of the science staff. Students were instructed in the use of sampling gear and scientific procedures encompassing many aspects of physical, geological, chemical and biological oceanography. Instruction was provided while performing oceanographic or marine biological research for either individual student projects, the work of SEA staff or long term cooperative programs. Routine meteorological and oceanic observations were made, the weather data being transmitted during science watches. Students were sufficiently familiar with scientific procedures during the last two weeks to operate activities of the laboratory without significant help from the science staff.

Formal instruction was provided on a daily basis in the form of lectures given by the science staff. Lecture topics, designed to cover aspects of oceanography and marine science not readily acquired from practical experience, are listed in Table 3.

Oceanographic studies fell into three categories: (1) Each student took to sea a well-planned project which could be completed during the period of the cruise. These projects were chosen and developed by the students and completed as independent research. A short seminar was given by each of the students at the end of the cruise, summarizing their findings. (2) Several projects, designed by the scientific staff, were completed to demonstrate or test particular oceanographic principles. These cruise projects required the participation of all student crew members in data collection, sample processing and data reduction. (3) Several long-term projects are being conducted by SEA staff members and associated organizations. These include meteorological observations, and analyses of the distribution and abundance of neuston.

Every oceanographic station was made for the purpose of actual research; no sample was taken solely for the purpose of demonstration. In this way, students were given the opportunity to learn by participation in actual research activities.

C-103 was comprised of two three-week courses in oceanography offered by Boston University through SEA. The on-board experience was preceded by a rigorous six-week course in oceanography on shore. Successful completion of the entire program (seventeen academic credits) included eleven credit hours in oceanography. Letter grades for each of the two shipboard courses were determined on the basis of on-watch evaluation, project research and final report, and a laboratory practical examination.

Table 3. - Science Lectures, C-103

| Date | Speaker | Title |
|---|---|---|
| Dec. 1 | P. Joyce | Lab Orientation and Safety |
| Dec. 2 | P. Joyce | EBT Operation |
| Dec. 5 | P. Joyce | Neuston Tow Organisms |
| Dec. 6 | S. Griscom | Geological Procedures and Sampling Techniques |
| Dec. 7 | K. Wilson | Salinometer Techniques |
| Dec. 7 | P. Joyce | Coral Reef Mortalities |
| Dec. 8 | C. Holloway | Salinometer and Fluorometer Techniques |
| Dec. 12 | A. Friedlander | Caribbean Water Masses |
| Dec. 13 | A. Friedlander | Caribbean Surface Circulation Patterns |
| Dec. 14 | T. Kenna | Sharks |
| Dec. 15 | C. Holloway | El Niño |
| Dec. 17 | S. Griscom & P. Joyce | Bonaire Geological Field Trip |
| Dec. 21 | Students | Creature Features |
| Dec. 22 | S. Griscom | Caribbean Geology |
| Dec. 22 | Students | Creature Features |
| Dec. 22 | M. Grashof | Aquaculture on Bonaire |
| Dec. 23 | S. Griscom | Caribbean Geology; The Chocolate Chunky Explanation |
| Dec. 24 | Staff | Laboratory Mid-Term Practical Exam |
| Dec. 25 | P. Joyce | Rock Dredge and Gravity Core Demonstration |
| Dec. 26 | M. Grashof | Sponge Research on Curacao |
| Dec. 27 | Students | Creature Features |
| Dec. 27 | P. Joyce | Student Project Seminar |
| Dec. 28 | M. Grashof | Oil Pollution in the North Sea |
| Dec. 28 | Students | Creature Features |
| Jan. 2 | Students | Creature Features |
| Jan. 2 | P. Joyce | Seminar; Student Project Integration |
| Jan. 3 | Students | Student Project Presentations |
| Jan. 4 | Students | Student Project Presentations |
| Jan. 5 | Students | Student Project Presentations |
| Jan. 6 | Students | Student Project Presentations |
| Jan. 9 | P. Joyce | Final Written Exam |

# 3 Student Paper Abstracts

## 3.1 Sediment and Bathymetric Analysis of the Saba Bank Region - Norman Allegar and Tim Bigelow

A Precision Depth Recorder profile and sediment sample transect lines were completed on Saba Bank, a extensive shallow water area southwest of Saba Island. Sediment samples were collected with a Fisher Scoop and a Shipek grab sampler. Sediments were dried and sieved, with the weight and composition of each fraction recorded. A fining of sediments with increasing depth off the bank was observed. The fraction of terrigenous grains in these sediment samples decreased with increasing distance from Saba Island. Particles derived from *Halimeda*, a coralline algae, were found more frequently in windward sediment samples than in those recovered from the leeward side of the bank. Bathymetric profiles produced by the precision depth recorder (PDR) showed the bank to rise sharply on the western edge to a depth of 40 m., then to gradually shoal to a depth of 20 m. Two sets of wave-cut terraces with associated reef complexes were observed at depths of 40 and 90 m. on the slope. These terraces correspond to the lowering of sea level during the Pleistocene. Both the PDR survey and sediment analyses indicate that the bank is growing to leeward, with sediment being supplied from the windward side.

## 3.2 Effects of High Energy Currents on the Banks of the Nicaraguan Rise
- Steven Hilger

The Pedro and Rosalind Banks of the Nicaraguan Rise are carbonate platforms located south and west of Jamaica. Carbonate sediment is continuously deposited, predominantly on the leeward slopes. Lateral growth of these banks can be attributed to the processes of erosion and subsequent deposition of sediments originating on both the bank-top and windward margin. The amount of leeward deposition is controlled by the amount of sediment produced in the shallow windward margin of the bank and the amount of sediment swept up by bottom currents. Subsurface currents affect the shape of the banks by sediment transport from the productive shallow margin and bank-top (windward) to the deeper margin (leeward). These subsurface currents are often caused by high energy pulses originating during hurricanes. Sediment samples were collected from Rosalind and Pedro Banks with a Fisher Scoop, Shipek grab sampler and rock dredge. The composition and size distribution of these sediments were analyzed. Both banks are productive benthic algal communities in which the windward margin is made up of a hard substrate colonized with coralline algae. Grain size distribution patterns suggest that both banks have been shaped by strong bottom currents, prevailing winds, hurricanes and intense storms.

3.3 The Production, Transport and Deposition of Calcareous Algae Sediments on the Windward and Leeward Sides of Baradel in the Tobago Cays
- Teryl K. Nuckols

The calcareous algae *Halimeda* often comprises as much 50% of the sediments accumulated in a barrier reef system such as that found in the Tobago Cays. The production, transport and deposition of these sediments on the windward and leeward sides of Baradel, an island of the Tobago Cays, were examined. The accumulated bottom sediments, distribution of calcareous algae and current strength and direction were studied at three locations near this island. The particle source and the local physical energy environment were found to be the primary determinants of sediment composition. A comparison of the size distribution and composition of accumulated sediments to the distribution of algae, and *in situ* current environment permitted the production of a theoretical model of sediment deposition in these waters. A high sedimentation rate was found to dominate one of the two windward areas studied, while currents dominated the second windward area. The effects of sediment origin and the physical energy environment were found to be equally important on the leeward side.

## 3.4 Circulation in the Eastern Caribbean and the Evaluation of the Countercurrent Hypothesis
- Jeff Lawson

The understanding of Caribbean Sea circulation has changed immensely from the model first described by George Wust in 1964. Recent studies describe a complex system of currents including small and mesoscale features. A possible permanent countercurrent, separating the north and south Caribbean Sea has been proposed (Duncan, 1982). The existence of such a countercurrent will have profound effects on the distribution of drifting pelagic materials, such as plastic, tar, *Sargassum* and a variety of larval organisms. EBT and CTD transects were completed approximately 25 nm. west of the Lesser Antilles during the winter of 1988-1989 to profile the physical structure of the eastern Caribbean Sea at this time. Geostrophic flow calculations resulting from these transects suggest the existence of the Caribbean Counter Current, at least during the period of this study, acting as a boundary between the northern and southern Caribbean. Smaller scale eddies and areas of regional downwelling were also observed, particularly in the lee of islands of the Lesser Antilles Island Arc.

## 3.5 The Intrusion of Amazon and Orinoco River Water into the Caribbean Basin
- Louis Nosce

The extent and nature of the intrusion of Amazon and Orinoco river water into the Caribbean Sea was studied during December, 1988. An east to west transect, consisting of surface salinity, temperature and silica samples and EBT and CTD casts, was completed in the southeastern Caribbean. A lens of Amazon/Orinoco water, characterized by salinities less than 35.5 0/00 and silica concentrations greater than 2.0 uM./l was located in the eastern Caribbean. This lens extended for approximately 100 nm. on its east-west axis, with a maximum depth of 30 m. The extent of intrusion of this water mass into the Caribbean was smaller than that found in previous years, and is likely the result of the cruise track crossing this water mass on an oblique section near its southern extreme.

## 3.6 An Examination of the Structure, Zonation and Faunal Distribution of the Coral Reefs of the Tobago Cays - Alexander vR. Gryska, Christopher W. Edgar and Joshua Belsky

The structure and diversity of the coral reef community of the Tobago Cays, located in the southern Lesser Antilles island arc, was studied. Three replicates of a two-meter square transect were completed in high, medium and low wave energy locations. The morphology, species composition and species diversity in each of these areas was found to be related to the depth, water flow and wave exposure at each site. The high energy zone was characterized by high water flow rates, large, massively branching corals and the highest species diversity. The water flow rate decreased by half in the medium energy zone. Low, rounded corals and the lowest species diversity were representative of this area. More fragile, branching hard and soft corals with an intermediate species diversity were found in the low energy, lagoon zone. Large areas of dead coral, noted during previous studies, are currently being re-colonized, primarily by *Acropora palmata*.

### 3.7 The Relationship between Chlorophyll-*a* Concentration and Surface Water Masses in the Caribbean Sea - Marci Glazer

Chlorophyll-*a* concentrations were determined at 32 surface stations in the eastern and southern Caribbean during the winter of 1988-1989. The mean chlorophyll concentration in the area of study was 0.11 µg/l. Chlorophyll-*a* concentrations were found to be a distinguishing characteristic of four different water masses encountered during the cruise. The mean value for chlorophyll-*a* in Southern Sargasso Sea water found north of 16°N was 0.06 µg/l. The mean chlorophyll-*a* concentration for eastern Caribbean water was 0.13 µg/l. The mean concentration for Amazon and Orinoco River water was 0.18 µg/l. The mean value for southern Caribbean water was 0.07 µg/l. There is only a very slight positive correlation of chlorophyll-*a* with phosphate concentrations. Caribbean surface chlorophyll-*a* concentrations are apparently more closely related to other physical and chemical variables than surface concentrations of the nutrient phosphate.

3.8 Physical Properties Affecting the Distribution of Myctophid Fishes in the Caribbean Sea
- Susan McCarthy

The distribution of myctophid fish in the Caribbean Sea was studied along cruise track C-103 of the SSV *Corwith Cramer*. Myctophids were sampled from St. Thomas to Jamaica using both day and night neuston net tows. The number and the length in cm. of all fish collected at a station was recorded. The distribution of myctophids was compared to several physical properties including nutrient concentration, areas of upwelling and downwelling as defined by isothermal sections, surface currents, surface temperature, salinity and zooplankton density. 206 myctophids, with an average length of 1.5 cm. were collected. The greatest densities of myctophids were found near Saba Bank, off the island of St. Lucia and north of Bonaire. A high phosphate concentration (>.5 µM./l) was found at all three of these stations, indicating high productivity. Other factors, such as mesoscale eddies and terrestrial runoff may have contributed to the greater abundance of myctophids in these areas. The high number of myctophid fish collected north of Bonaire is thought to be the result of an area of upwelling north of the coast of South America. Relatively fewer numbers of myctophids were found south of Jamaica which is likely the result of convergence or downwelling in this area. A slight positive correlation between the number of myctophids in night tows and the average zooplankton density was found; however, there are undoubtedly other variables affecting the distribution of myctophids in the Caribbean Sea.

### 3.9 A Study of The Distribution of the Phyllosoma Larvae of the Spiny Lobster in the Caribbean Sea
- Christa Daly

Phyllosoma, the planktonic larvae of the spiny lobster *Panulirus argus*, were collected in neuston tows in the eastern and southern Caribbean during the winter of 1988-89. Two pre-juvenile puerulus forms were collected near St. Thomas and forty-six larval forms were collected in neuston tows 32 miles west of the island of Guadeloupe. All individuals were classified between the sixth and tenth larval stages. No other larvae were collected during the remainder of the study period. This is consistent with historical SEA data, which record few phyllosoma in winter Caribbean neuston tows, except in areas where southern Sargasso Sea water enters the Caribbean Sea through the Windward and Anegada Passages. The present study and past SEA data suggest that very few Stage V and older phyllosoma larvae are found in surface waters during the winter south of a line at approximately 13 degrees north latitude, following the intrusion of surface Sargasso Sea water.

## 3.10 *Halobates micans* in the Caribbean Sea; Distribution and Abundance in Relation to Zooplankton Density and other Tangible Factors
- David Neuman

*Halobates micans* is one of five insect species that have made the ocean surface their home. These creatures have adapted to this strange environment by losing their wings and skimming on the water's surface. Only *H. micans* occupies the Southwest North Atlantic Ocean and Caribbean Sea. Regional factors play a part in the distribution and abundance of these insects. However, little is known of the biology of these organisms, as they are very hard to rear and keep in captivity. The abundance and distribution of these insects in the Caribbean Sea was studied during C-103 aboard SSV *Corwith Cramer*. The numbers of male, female and nymphal *Halobates micans* captured in paired neuston tows were compared to various other components of the neuston, including zooplankton density, *Sargassum* density and surface salinity. 1424 *Halobates* were collected throughout the eastern Caribbean during the course of this study. *Halobates* were found in significantly greater numbers in night tows when compared to day tows ($p<0.05$), indicating the ability to detect and avoid the neuston net during the day.

### 3.11 The Influence of Nutrients and Currents on the Horizontal Distribution of the Leptocephali
- Carolyn H. Nichols

Samples of leptocephali or eel larvae were collected from December 1, 1988 to January 10, 1989 along a six week cruise tract through the Caribbean Sea from St. Thomas to Miami. Leptocephali were collected twice daily using paired neuston tows. Surface temperature and salinity, silica, phosphate and chlorophyll concentrations were determined for each station. Each individual leptocephus was measured and identified to species. A total of 155 leptocephali were caught at seven stations during this cruise. The Opichthidae, snake eels, were most frequently caught. The leptocephali were found to increase in length from north to south along a line St. Thomas to the Tobago Cays. Leptocephali were found to increase in both size and numbers with increasing phosphate, chlorophyll-*a* concentrations and proximity to land, but to have no significant relationship to temperature, silicate concentration or salinity.

## 3.12 The Distribution of Pelagic *Sargassum* in the Caribbean Sea - Pauline Power

A quantitative analysis of pelagic *Sargassum* spp. was undertaken in the Caribbean Sea. Both *S. natans* and *S. fluitans* were gathered in a total of 31 neuston tows. A boundary of significant occurrence was observed from 15°N in the eastern Caribbean to 17°N in the Western Caribbean. No *Sargassum* spp. was found south of this line. The distribution limit of *Sargassum* is similar to that observed for the intrusion of surface Sargasso Sea water into the Caribbean Sea. Sargasso Sea Water does not penetrate into the southern Caribbean because of the dominance of the Southern and Northern Equatorial Currents. The mean density of *Sargassum* sp. found was 0.019 ml./m2. The ratio of *S. natans* to *S. fluitans* was calculated at 2.1 : 1, matching similar findings that *S. natans* is the more dominant species in the Caribbean. The age of the *Sargassum* sp. was also studied giving evidence of the dominance of medium to young *Sargassum* sp. in the Caribbean, possibly due to the direct input from a source in the Southern Sargasso Sea.

### 3.13 Biomass Distribution Patterns of Zooplankton: The Island Mass Effect in the Lesser Antilles
- Patrick M. Liu and Laura M. Taylor

Previous research has documented an offshore/onshore gradient in zooplankton density on the leeward side of the Lesser Antilles Island Arc. This observation has been attributed to the island mass effect, the collected biological, physical and chemical consequences of water circulation around a land mass. Surface zooplankton was collected along a transect running from St. Thomas to Bequia using paired neuston tows. These tows were conducted 25 nm. offshore from major islands and in their corresponding channels. Zooplankton biomass was next measured twice daily in a second, east to west transect from Bequia to Bonaire. Zooplankton biomass densities in the lee of islands were found to be greater than channel densities ($p<0.2$), while density decreased from Bequia to Bonaire. Zooplankton density was found to be significantly greater in Equatorial Current waters than Sargasso Sea waters ($p<0.01$). The distribution of zooplankton standing crop between island and channel and the observed onshore/offshore gradient form Bequia to Bonaire suggest the presence of an island mass on zooplankton density in the Lesser Antilles.

3.14 Distribution of Pelagic Tar in the Caribbean Sea
- Eileen D. Early

Pelagic tar is a direct result of petroleum pollution in the world's oceans. Sources of this oil are both natural and anthropogenic, with the ratio of natural input of oil to anthropogenic sources being approximately 1:7. Pelagic tar found in the region of the Caribbean is a result of sources both internal and external to the Caribbean.

Surface tar, micro-tar and tar accumulations on beaches were sampled. Paired neuston tows, each one nautical mile in length, were deployed twice daily. Surface tar particles were separated from these samples. 100 ml. surface samples, collected at six hour intervals during the course of the cruise, were passed through a gridded 0.45 µm. filter for micro-tar . Beach transects sampled the abundance of accumulated tar on beaches during port stops.

Surface tar and micro-tar were found in greatest densities in the Eastern Caribbean along a transect completed 25 nm. west of the Lesser Antilles. Lesser amounts of both forms were found in the central and Western Caribbean, with the exception of localized areas of high density near Bonaire and Roatan. In general, older tar particles were found in the eastern Caribbean, with age decreasing with distance to the west. Highest concentrations of beach tar were found on the windward beaches of Bonaire. Beach tar was found in significantly higher densities on windward than leeward beaches in all areas of study. The observed distribution of tar in the Caribbean suggests that local inputs are an important tar source, particularly in the vicinity of South America. Windward beaches act as a sink for a substantial amount of pelagic tar.

### 3.15 The Distribution of Pelagic and Terrestrial Plastics in the Caribbean Sea
- Randa Chehab and Matt Samuelson

The C-103 cruise track was divided into three transects: one north to south from St. Thomas to Bequia, and two east to west, from Bequia to Bonaire and Bonaire to Roatan. Surface waters were sampled for pelagic plastic using paired neuston tows one nautical mile in length. Beach plastic was sampled through the use of three replicate 2.5 meter square beach transects, with 30 centimeter square sub-transects in the upper left and lower right hand corners sieved for small particles on windward and leeward sides of the islands. Neuston tow and beach transect data were standardized to 1000 and 1 meter square areas, respectively, allowing direct comparison of the two. The mean number of pieces of plastic per tow was 1.6. The mean number of pellets per tow was 0.29. The mean number of pieces on the windward side of beaches was 249.6 with a standard deviation of 115.2. The mean number of pieces on the leeward side of beaches was 9.6 with a standard deviation of 7.4. The mean number of pellets found on the windward sides was 30 with a standard deviation of 33.95. No pellets were found on the leeward sides of any island.

These data indicate sources for pelagic plastic both outside and within the boundaries of the Caribbean. The general increase in plastic density, and labels found on many individual pieces suggest that South American and local inputs are the dominant source of plastic pollution in the southern Caribbean. Windward beaches in the Lesser Antilles remove some significant amount of floating plastic entering the Caribbean in this area.

# 4 Appendix

## 4.1 Appendix A - C-103 Oceanographic Stations

| Station | Type | Date | Time | Log (nm.) | Lat N. | Long W. |
|---|---|---|---|---|---|---|
| C-103-031 | CTD | 12/05/88 | 1415 | 227.0 | 16°20 | 63°08 |
| C-103-032 | CTD | 12/05/88 | 1809 | 246.2 | 16°03 | 63°00 |
| C-103-033 | CTD | 12/06/88 | 0010 | 288.2 | 16°07 | 62°15 |
| C-103-035 | CTD | 12/06/88 | 1140 | 304.0 | 16°00 | 62°00 |
| C-103-037 | CTD | 12/06/88 | 1953 | 350.4 | 15°15 | 61°51 |
| C-103-039 | CTD | 12/07/88 | 0500 | 371.7 | 15°02 | 61°44 |
| C-103-041 | CTD | 12/07/88 | 1005 | 391.8 | 14°33 | 61°33 |
| C-103-044 | CTD | 12/07/88 | 1715 | 416.7 | 14°07 | 61°24 |
| C-103-045 | CTD | 12/07/88 | 2010 | 431.2 | 14°04 | 61°23 |
| C-103-047 | CTD | 12/08/88 | 0130 | 449.6 | 13°40 | 61°22 |
| C-103-050 | CTD | 12/08/88 | 0939 | 479.5 | 13°12 | 61°25 |
| C-103-052 | CTD | 12/08/88 | 2000 | 507.6 | 13°03 | 61°19 |
| C-103-055 | CTD | 12/13/88 | 1414 | 650.6 | 12°33 | 63°04 |
| C-103-056 | CTD | 12/14/88 | 0007 | 700.5 | 12°21 | 63°50 |
| C-103-058 | CTD | 12/14/88 | 1200 | 756.0 | 12°22 | 64°54 |
| C-103-060 | CTD | 12/15/88 | 0011 | 808.6 | 12°32 | 66°07 |
| C-103-062 | CTD | 12/15/88 | 1200 | 869.3 | 12°39 | 67°03 |
| C-103-065 | CTD | 12/20/88 | 0000 | 1021.8 | 13°03 | 68°38 |
| C-103-068 | CTD | 12/21/88 | 1215 | 1282.6 | 16°19 | 72°18 |
| C-103-070 | CTD | 12/22/88 | 0005 | 1363.6 | 16°59 | 73°55 |
| C-103-072 | CTD | 12/22/88 | 1211 | 1426.9 | 17°21 | 74°52 |
| C-103-074 | CTD | 12/23/88 | 0000 | 1493.6 | 17°23 | 76°17 |
| C-103-096 | CTD | 12/27/88 | 1200 | 1869.9 | 16°41 | 83°28 |
| C-103-098 | CTD | 12/28/88 | 0000 | 1919.3 | 16°30 | 84°21 |
| C-103-099 | CTD | 12/28/88 | 1200 | 1968.3 | 16°32 | 85°23 |
| C-103-105 | CTD | 01/04/89 | 1407 | 2357.9 | 21°16 | 86°12 |
| C-103-003 | Fisher Scoop | 12/04/88 | 0711 | 140.6 | 17°33 | 63°27 |
| C-103-004 | Fisher Scoop | 12/04/88 | 0730 | 141.1 | 17°32 | 63°26 |
| C-103-005 | Fisher Scoop | 12/04/88 | 0743 | 141.6 | 17°32 | 63°26 |
| C-103-006 | Fisher Scoop | 12/04/88 | 0751 | 142.0 | 17°31 | 63°24 |
| C-103-007 | Fisher Scoop | 12/04/88 | 0800 | 142.5 | 17°31 | 63°24 |
| C-103-008 | Fisher Scoop | 12/04/88 | 0954 | 146.1 | 17°35 | 63°27 |
| C-103-010 | Fisher Scoop | 12/04/88 | 1021 | 146.2 | 17°35 | 63°27 |
| C-103-013 | Fisher Scoop | 12/04/88 | 1212 | 148.1 | 17°39 | 63°29 |
| C-103-014 | Fisher Scoop | 12/04/88 | 1250 | 150.8 | 17°39 | 63°29 |
| C-103-016 | Fisher Scoop | 12/04/88 | 1455 | 155.9 | 17°34 | 63°34 |
| C-103-017 | Fisher Scoop | 12/04/88 | 1526 | 156.4 | 17°32 | 63°35 |
| C-103-018 | Fisher Scoop | 12/04/88 | 1535 | 157.9 | 17°31 | 63°34 |
| C-103-020 | Fisher Scoop | 12/04/88 | 1629 | | 17°31 | 63°35 |
| C-103-021 | Fisher Scoop | 12/04/88 | 1717 | | 17°31 | 63°36 |
| C-103-022 | Fisher Scoop | 12/04/88 | 1732 | | 17°31 | 63°36 |
| C-103-023 | Fisher Scoop | 12/04/88 | 1828 | | 17°27 | 63°36 |
| C-103-024 | Fisher Scoop | 12/04/88 | 1910 | 161.8 | 17°26 | 63°35 |
| C-103-025 | Fisher Scoop | 12/04/88 | 2010 | 161.9 | 17°05 | 63°37 |
| C-103-026 | Fisher Scoop | 12/04/88 | 2040 | 162.4 | 17°31 | 63°35 |
| C-103-027 | Fisher Scoop | 12/04/88 | 2120 | 163.9 | 17°20 | 63°36 |

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|---|---|---|---|---|---|---|
| C-103-028 | Fisher Scoop | 12/04/88 | 2145 | 167.6 | 17°20 | 63°38 |
| C-103-076 | Fisher Scoop | 12/23/88 | 1020 | 1540.7 | 17°33 | 77°05 |
| C-103-078 | Fisher Scoop | 12/23/88 | 2150 | 1596.3 | 17°10 | 77°48 |
| C-103-079 | Fisher Scoop | 12/24/88 | 0000 | 1596.7 | 17°10 | 77°51 |
| C-103-080 | Fisher Scoop | 12/24/88 | 0440 | 1602.1 | 17°05 | 77°53 |
| C-103-081 | Fisher Scoop | 12/24/88 | 0640 | 1602.1 | 17°05 | 77°59 |
| C-103-086 | Fisher Scoop | 12/24/88 | 1405 | 1627.8 | 17°01 | 78°27 |
| C-103-088 | Fisher Scoop | 12/25/88 | 1955 | 1729.1 | 16°25 | 80°24 |
| C-103-089 | Fisher Scoop | 12/25/88 | 2200 | 1729.1 | 16°24 | 80°25 |
| C-103-090 | Fisher Scoop | 12/26/88 | 0008 | 1729.1 | 16°23 | 80°27 |
| C-103-091 | Fisher Scoop | 12/26/88 | 0212 | | 16°21 | 80°29 |
| C-103-092 | Fisher Scoop | 12/26/88 | 0345 | | 16°20 | 80°24 |
| C-103-001 | Neuston | 12/03/88 | 1757 | 69.2 | 18°11 | 64°32 |
| C-103-002 | Neuston | 12/04/88 | 0010 | 109.7 | 17°59 | 63°48 |
| C-103-029 | Neuston | 12/05/88 | 0213 | 189.6 | 17°07 | 63°32 |
| C-103-030 | Neuston | 12/05/88 | 1205 | 221.8 | 16°27 | 63°14 |
| C-103-034 | Neuston | 12/06/88 | 0035 | 288.6 | 16°07 | 62°15 |
| C-103-036 | Neuston | 12/06/88 | 1203 | 306.7 | 15°51 | 62°13 |
| C-103-038 | Neuston | 12/06/88 | 2043 | 351.0 | 15°13 | 61°51 |
| C-103-040 | Neuston | 12/07/88 | 0548 | 370.8 | 14°58 | 61°40 |
| C-103-042 | Neuston | 12/07/88 | 1028 | 392.1 | 14°33 | 61°33 |
| C-103-043 | Neuston | 12/07/88 | 1530 | 412.0 | 14°10 | 61°22 |
| C-103-046 | Neuston | 12/07/88 | 2100 | 431.6 | 13°52 | 61°15 |
| C-103-048 | Neuston | 12/08/88 | 0152 | 449.7 | 13°38 | 61°22 |
| C-103-049 | Neuston | 12/08/88 | 0805 | 477.0 | 13°15 | 61°27 |
| C-103-051 | Neuston | 12/08/88 | 1822 | 504.1 | 13°04 | 61°19 |
| C-103-052 | Neuston | 12/13/88 | 0021 | 583.1 | 12°41 | 62°00 |
| C-103-054 | Neuston | 12/13/88 | 1250 | 647.0 | 12°36 | 63°01 |
| C-103-057 | Neuston | 12/14/88 | 0042 | 700.5 | 12°21 | 63°50 |
| C-103-059 | Neuston | 12/14/88 | 1220 | 756.7 | 12°22 | 64°55 |
| C-103-061 | Neuston | 12/15/88 | 0011 | 808.6 | 12°32 | 66°07 |
| C-103-063 | Neuston | 12/15/88 | 1225 | 870.2 | 12°34 | 67°12 |
| C-103-064 | Neuston | 12/16/88 | 0018 | 928.0 | 12°00 | 68°14 |
| C-103-066 | Neuston | 12/20/88 | 0100 | 1021.8 | 13°12 | 68°43 |
| C-103-067 | Neuston | 12/20/88 | 1300 | 1099.9 | 14°13 | 69°38 |
| C-103-069 | Neuston | 12/21/88 | 1236 | 1283.0 | 16°19 | 72°18 |
| C-103-071 | Neuston | 12/22/88 | 0043 | 1364.4 | 16°60 | 73°58 |
| C-103-073 | Neuston | 12/22/88 | 1239 | 1427.0 | 17°21 | 74°52 |
| C-103-075 | Neuston | 12/23/88 | 0115 | 1493.9 | 17°18 | 76°06 |
| C-103-077 | Neuston | 12/23/88 | 1200 | 1553.5 | 17°34 | 77°10 |
| C-103-097 | Neuston | 12/27/88 | 1200 | 1869.9 | 16°41 | 83°28 |
| C-103-100 | Neuston | 12/28/88 | 1302 | 1968.7 | 16°34 | 85°30 |
| C-103-101 | Neuston | 12/29/88 | 0113 | 2024.3 | 16°20 | 85°59 |
| C-103-102 | Neuston | 01/02/89 | 1315 | 2139.9 | 17°37 | 85°54 |
| C-103-103 | Neuston | 01/03/89 | 1216 | 2253.9 | 19°28 | 86°03 |
| C-103-104 | Neuston | 01/04/89 | 1225 | 2355.8 | 21°14 | 86°16 |
| C-103-106 | Neuston | 01/05/89 | 1210 | 2452.2 | 22°34 | 86°15 |
| C-103-107 | Neuston | 01/06/89 | 1210 | 2583.8 | 23°22 | 84°23 |
| C-103-009 | Rock Dredge | 12/04/88 | 1003 | 146.2 | 17°35 | 63°27 |
| C-103-095 | Rock Dredge | 12/26/88 | 0824 | | 16°23 | 80°47 |
| C-103-011 | Shipek Grab | 12/04/88 | 1031 | 146.2 | 17°35 | 63°29 |
| C-103-012 | Shipek Grab | 12/04/88 | 1147 | 147.7 | 17°36 | 63°29 |

| | | | | | | |
|---|---|---|---|---|---|---|
| C-103-015 | Shipek Grab | 12/04/88 | 1323 | 150.5 | 17°35 | 63°29 |
| C-103-019 | Shipek Grab | 12/04/88 | 1603 | 157.8 | 17°30 | 63°34 |
| C-103-082 | Shipek Grab | 12/24/88 | 0726 | 1602.1 | 17°05 | 77°59 |
| C-103-083 | Shipek Grab | 12/24/88 | 0941 | 1611.7 | 17°02 | 78°06 |
| C-103-084 | Shipek Grab | 12/24/88 | 0947 | 1611.7 | 17°03 | 78°06 |
| C-103-085 | Shipek Grab | 12/24/88 | 1229 | 1620.5 | 17°00 | 78°22 |
| C-103-087 | Shipek Grab | 12/25/88 | 1520 | 1727.4 | 16°26 | 80°23 |
| C-103-093 | Shipek Grab | 12/26/88 | 0600 | | 16°26 | 80°40 |
| C-103-094 | Shipek Grab | 12/26/88 | 0802 | 1734.5 | 16°24 | 80°47 |

## 4.2 Appendix B - Surface Sample Data

| Station | Date | Time | Log (nm.) | Lat N. | Long W. | Salinity (0/00) | SiO2 µM./l | PO4 µM./l | Chl µg/l |
|---|---|---|---|---|---|---|---|---|---|
| SS-001 | 03-Dec-88 | 1800 | 66.0 | 18°11 | 64°32 | 35.390 | 3.3 | 0.41 | |
| SS-002 | 04-Dec-88 | 0200 | 117.8 | 18°58 | 63°40 | 35.250 | 5.4 | 0.45 | 0.1 |
| SS-003 | 04-Dec-88 | 0600 | 137.2 | 17°37 | 63°29 | 35.173 | 3.2 | 0.35 | 0.1 |
| SS-004 | 04-Dec-88 | 1800 | 146.0 | 17°28 | 63°36 | 35.142 | 3.5 | 0.32 | |
| SS-005 | 05-Dec-88 | 0000 | 179.5 | 17°08 | 63°35 | 35.183 | 3.3 | 0.30 | 0.1 |
| SS-006 | 05-Dec-88 | 0600 | 206.3 | 16°52 | 63°21 | 35.270 | 4.4 | 0.22 | |
| SS-007 | 05-Dec-88 | 1300 | 224.2 | 16°22 | 63°16 | 35.401 | | | 0.1 |
| SS-008 | 05-Dec-88 | 1800 | 246.2 | 16°12 | 63°00 | 35.500 | 3.1 | 0.34 | 0.1 |
| SS-009 | 06-Dec-88 | 0000 | 287.0 | 16°07 | 62°15 | 35.204 | | 0.30 | 0.1 |
| SS-010 | 06-Dec-88 | 0600 | 302.2 | 15°58 | 62°16 | 35.538 | 1.8 | 0.24 | 0.2 |
| SS-011 | 06-Dec-88 | 1200 | 356.8 | 15°51 | 62°13 | 35.268 | | 0.68 | |
| SS-012 | 06-Dec-88 | 1820 | 344.5 | 15°20 | 61°48 | 35.555 | | 0.31 | 0.1 |
| SS-013 | 07-Dec-88 | 0000 | 359.2 | 15°07 | 61°46 | 35.717 | 1.3 | 0.38 | 0.1 |
| SS-014 | 07-Dec-88 | 0600 | 372.2 | 14°58 | 61°40 | 35.552 | | 0.35 | |
| SS-015 | 07-Dec-88 | 1200 | 393.7 | 14°33 | 61°33 | 35.485 | | 0.37 | 0.1 |
| SS-016 | 07-Dec-88 | 1800 | 418.1 | 14°04 | 61°23 | 35.559 | 1.6 | 0.30 | 0.1 |
| SS-017 | 07-Dec-88 | 2000 | 431.2 | 14°04 | 61°23 | 35.528 | 1.8 | | |
| SS-018 | 08-Dec-88 | 0000 | 443.2 | 13°46 | 61°28 | 35.575 | 1.4 | 0.35 | 0.2 |
| SS-019 | 08-Dec-88 | 0400 | 456.0 | 13°35 | 61°23 | 35.504 | 5.9 | | |
| SS-020 | 08-Dec-88 | 0600 | 464.8 | 13°26 | 61°29 | 35.543 | 1.7 | | |
| SS-021 | 08-Dec-88 | 0800 | 477.0 | 13°15 | 61°27 | 35.508 | | | |
| SS-022 | 08-Dec-88 | 1345 | 486.1 | 13°10 | 61°23 | 35.520 | | 0.32 | 0.1 |
| SS-023 | 08-Dec-88 | 1605 | 498.8 | 13°09 | 61°17 | 35.531 | 1.9 | | |
| SS-024 | 08-Dec-88 | 1800 | 502.1 | 13°05 | 61°18 | 35.606 | 1.6 | 0.65 | 0.1 |
| SS-025 | 12-Dec-88 | 1800 | 548.6 | 12°34 | 61°30 | 35.768 | 0.0 | 2.75 | 0.3 |
| SS-026 | 12-Dec-88 | 2000 | | 12°33 | 61°40 | 35.112 | | | |
| SS-027 | 12-Dec-88 | 2200 | 569.9 | 12°32 | 61°52 | 35.557 | 0.3 | | |
| SS-028 | 13-Dec-88 | 0000 | 582.8 | 12°41 | 62°01 | 35.342 | 0.1 | 0.14 | 0.1 |
| SS-029 | 13-Dec-88 | 0200 | 589.2 | 12°45 | 62°07 | 35.220 | 1.9 | | |
| SS-030 | 13-Dec-88 | 0400 | 599.2 | 12°56 | 62°14 | 35.463 | 1.6 | | |
| SS-031 | 13-Dec-88 | 0545 | 609.0 | 13°01 | 62°18 | 35.354 | 1.7 | 0.13 | 0.1 |
| SS-032 | 13-Dec-88 | 0805 | 621.0 | 13°05 | 62°32 | 35.468 | 0.1 | 0.17 | 0.1 |
| SS-033 | 13-Dec-88 | 1000 | 633.4 | 12°54 | 62°35 | 35.561 | | | |
| SS-034 | 13-Dec-88 | 1236 | 646.0 | 12°37 | 63°01 | 35.505 | | 0.08 | 0.1 |
| SS-035 | 13-Dec-88 | 1425 | 650.5 | 12°33 | 63°04 | 35.427 | | | |
| SS-036 | 13-Dec-88 | 1600 | 658.7 | 12°31 | 63°11 | 35.384 | | | |
| SS-037 | 13-Dec-88 | 1800 | 669.0 | 12°29 | 63°21 | 35.735 | | 0.17 | 0.1 |
| SS-038 | 13-Dec-88 | 2000 | 672.0 | 12°26 | 63°29 | 35.547 | 1.8 | | |
| SS-039 | 13-Dec-88 | 2200 | 690.1 | 12°24 | 63°39 | 34.803 | 4.3 | | |
| SS-040 | 14-Dec-88 | 0000 | 700.5 | 12°21 | 63°50 | 34.286 | 7.2 | 0.24 | 0.2 |
| SS-041 | 13-Dec-88 | 0200 | 705.6 | 12°20 | 63°56 | 34.141 | 7.6 | | |
| SS-042 | 14-Dec-88 | 0400 | 714.1 | 12°19 | 64°03 | 34.207 | 9.3 | | |
| SS-043 | 14-Dec-88 | 0600 | 726.7 | 12°20 | 64°22 | 34.462 | 5.2 | 0.21 | 0.2 |
| SS-044 | 14-Dec-88 | 0740 | 734.4 | 12°21 | 64°33 | 33.278 | 6.5 | | |
| SS-045 | 14-Dec-88 | 0800 | 737.6 | 12°20 | 63°32 | 32.885 | 7.6 | | |
| SS-046 | 14-Dec-88 | 1000 | 746.8 | 12°21 | 64°43 | 32.685 | 7.5 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SS-047 | 14-Dec-88 | 1200 | 756.0 | 12°22 | 64°54 | 32.636 | 7.0 | 0.43 | 0.2 |
| SS-048 | 14-Dec-88 | 1412 | 760.7 | 12°22 | 64°59 | 32.690 | 6.9 | | |
| SS-049 | 14-Dec-88 | 1610 | 770.8 | 12°22 | 65°19 | 34.567 | 3.5 | | |
| SS-050 | 14-Dec-88 | 1800 | 779.9 | 12°24 | 65°28 | 35.573 | | 0.39 | 0.1 |
| SS-051 | 14-Dec-88 | 2015 | 787.3 | 12°30 | 65°50 | 36.359 | | | |
| SS-052 | 14-Dec-88 | 2200 | 797.6 | 12°31 | 65°50 | 36.354 | | | |
| SS-053 | 15-Dec-88 | 0000 | | 12°32 | 66°07 | 36.129 | | 0.67 | 0.1 |
| SS-054 | 15-Dec-88 | 0200 | 811.4 | 12°36 | 66°01 | 35.014 | | | |
| SS-055 | 15-Dec-88 | 0400 | 825.2 | 12°37 | 66°20 | 35.916 | | | |
| SS-056 | 15-Dec-88 | 0630 | | 12°39 | 66°45 | 34.956 | 4.6 | 0.14 | 0.1 |
| SS-057 | 15-Dec-88 | 0820 | 847.1 | 12°41 | 66°46 | 34.992 | 4.6 | | |
| SS-058 | 15-Dec-88 | 1000 | 858.5 | 12°36 | 65°01 | 35.374 | 3.0 | | |
| SS-059 | 15-Dec-88 | 1200 | 869.3 | 12°39 | 67°03 | 35.489 | 6.1 | 0.30 | 0.1 |
| SS-060 | 15-Dec-88 | 1400 | 876.8 | 12°34 | 67°11 | 35.999 | 2.3 | | |
| SS-061 | 15-Dec-88 | 1600 | 887.6 | 12°35 | 67°16 | 35.998 | 2.6 | | |
| SS-062 | 15-Dec-88 | 1800 | 898.8 | 12°22 | 67°35 | 35.856 | 1.1 | 0.19 | 0.1 |
| SS-063 | 15-Dec-88 | 2000 | 908.9 | 12°12 | 67°57 | 35.205 | 3.8 | | |
| SS-064 | 15-Dec-88 | 2200 | 918.4 | 12°05 | 68°07 | 34.992 | 4.0 | | |
| SS-065 | 16-Dec-88 | 0000 | 928.0 | 12°00 | 68°14 | 35.116 | 4.3 | 0.30 | 0.1 |
| SS-066 | 19-Dec-88 | 1800 | 974.0 | 12°08 | 68°29 | 35.500 | 2.2 | 0.03 | |
| SS-067 | 20-Dec-88 | 0125 | 1023.0 | 13°16 | 68°47 | 34.873 | 1.7 | 1.38 | |
| SS-068 | 20-Dec-80 | 0600 | 1050.1 | 13°45 | 69°09 | 34.707 | 2.7 | 0.15 | |
| SS-069 | 20-Dec-88 | 1200 | 1097.7 | 14°13 | 69°38 | 35.276 | 4.5 | 0.13 | |
| SS-070 | 20-Dec-88 | 1800 | 1133.9 | 14°52 | 70°04 | 35.313 | | 0.69 | |
| SS-071 | 21-Dec-88 | 0000 | 1191.9 | 15°38 | 70°41 | 36.169 | 4.6 | 0.36 | |
| SS-072 | 21-Dec-88 | 0620 | 1240.5 | 16°00 | 71°40 | 36.168 | 7.3 | 0.15 | |
| SS-073 | 21-Dec-88 | 1200 | 1282.1 | 16°17 | 72°16 | 36.097 | 8.4 | 0.47 | |
| SS-074 | 21-Dec-88 | 1900 | 1319.5 | 16°34 | 73°01 | 35.340 | 4.0 | 0.93 | |
| SS-075 | 22-Dec-88 | 0005 | 1363.6 | 16°59 | 73°55 | 35.570 | 3.9 | | |
| SS-076 | 22-Dec-88 | 0600 | 1395.5 | 17°02 | 74°22 | 35.990 | 3.4 | 0.17 | |
| SS-077 | 22-Dec-88 | 1238 | 1427.0 | 17°21 | 74°52 | 35.546 | 3.8 | 2.10 | |
| SS-078 | 22-Dec-88 | 1800 | 1449.5 | 17°28 | 75°15 | 35.422 | | 0.21 | |
| SS-079 | 23-Dec-88 | 0000 | 1493.6 | 17°23 | 76°17 | 35.356 | 3.4 | 0.38 | |
| SS-080 | 23-Dec-88 | 0600 | 1515.2 | 17°22 | 76°28 | 35.386 | 3.6 | 0.21 | |
| SS-081 | 23-Dec-88 | 1200 | 1553.5 | 17°34 | 77°10 | 35.245 | 4.8 | 0.20 | |
| SS-082 | 23-Dec-88 | 1755 | 1576.8 | 17°23 | 77°32 | 35.374 | 4.1 | 0.38 | |
| SS-083 | 24-Dec-88 | 0000 | 1596.3 | 17°10 | 77°51 | 35.437 | 3.6 | 1.64 | |
| SS-084 | 24-Dec-88 | 0500 | 1602.1 | 17°05 | 77°53 | 35.535 | 3.3 | 0.11 | |
| SS-085 | 24-Dec-88 | 1200 | 1619.5 | 17°00 | 78°19 | 35.543 | 3.3 | 0.79 | |
| SS-086 | 24-Dec-88 | 1800 | 1641.5 | 17°01 | 78°45 | 35.421 | 4.7 | | |
| SS-087 | 25-Dec-88 | 0600 | 1689.8 | 16°45 | 78°36 | 35.516 | 3.1 | 0.12 | |
| SS-088 | 25-Dec-88 | 1200 | 1714.2 | 16°33 | 80°06 | 35.524 | 3.8 | 0.24 | |
| SS-089 | 25-Dec-88 | 1800 | 1729.1 | 16°26 | 80°23 | 35.855 | 4.0 | 0.73 | |
| SS-090 | 26-Dec-88 | 1200 | 1741.3 | 16°21 | 80°57 | 35.744 | 7.3 | | |
| SS-091 | 26-Dec-88 | 1800 | 1773.3 | 16°25 | 81°29 | 35.879 | | | |
| SS-092 | 27-Dec-88 | 0000 | 1815.2 | 16°33 | 82°29 | 36.075 | | | |
| SS-093 | 27-Dec-88 | 0600 | 1841.8 | 16°36 | 83°02 | 35.991 | | | |
| SS-094 | 27-Dec-88 | 1200 | 1869.9 | 16°41 | 83°28 | 35.698 | | | |
| SS-095 | 27-Dec-88 | 1800 | 1893.2 | 16°38 | 83°18 | 35.822 | | | |
| SS-096 | 28-Dec-88 | 0000 | 1919.3 | 16°30 | 84°21 | 34.512 | | | |
| SS-097 | 28-Dec-88 | 0600 | 1943.3 | 16°28 | 84°49 | 33.647 | | | |
| SS-098 | 28-Dec-88 | 1250 | 1969.5 | 16°31 | 85°23 | 34.157 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| SS-099 | 28-Dec-88 | 1800 | 1988.5 | 16°26 | 85°47 | 33.906 |
| SS-100 | 29-Dec-88 | 0030 | 2018.7 | 16°19 | 85°47 | 34.035 |
| SS-101 | 29-Dec-88 | 0615 | 2053.5 | 16°19 | 86°21 | 35.248 |
| SS-102 | 01-Jan-89 | 1800 | | 16°27 | 86°13 | 34.733 |
| SS-103 | 02-Jan-89 | 0000 | 2087.6 | 16°40 | 85°57 | 35.898 |
| SS-104 | 02-Jan-89 | 0600 | 2108.7 | 17°06 | 85°57 | 35.275 |
| SS-105 | 02-Jan-89 | 1200 | 2137.0 | 17°37 | 85°54 | 35.989 |
| SS-106 | 02-Jan-89 | 1800 | 2160.4 | 18°05 | 86°14 | 35.425 |
| SS-107 | 03-Jan-89 | 0000 | 2177.3 | 18°15 | 86°20 | 35.161 |
| SS-108 | 03-Jan-89 | 0600 | 2221.9 | 18°56 | 86°07 | 35.851 |
| SS-109 | 03-Jan-89 | 1800 | 2275.3 | 19°53 | 86°12 | 36.408 |
| SS-110 | 03-Jan-89 | 1800 | 2275.3 | 19°52 | 86°13 | |
| SS-111 | 04-Jan-89 | 0000 | 2304.2 | 20°27 | 86°20 | |
| SS-112 | 04-Jan-89 | 0600 | 2331.6 | 21°00 | 86°32 | |

## 4.3 Appendix C - Neuston Tow Data

| Station | Tow X m. | Sarg. g. | Halo. n. | Lepto. n. | Myc. n. | Phyl. n. | Zoop. g. | Tar g. | Plastic n. |
|---|---|---|---|---|---|---|---|---|---|
| C-103-001 | 3704 | 430 | 12 | 0 | 7 | 0 | 40 | 0.25 | 2 |
| C-103-002 | 3148 | 50 | 6 | 11 | 46 | 0 | 37 | 1.40 | 0 |
| C-103-029 | 6852 | 2 | 8 | 0 | 5 | 0 | 26 | 0.00 | 0 |
| C-103-030 | 4445 | 140 | 0 | 0 | 0 | 0 | 7 | 0.04 | 0 |
| C-103-034 | 3704 | 262 | 50 | 2 | 10 | 32 | 40 | 0.16 | 0 |
| C-103-036 | 3704 | 0 | 44 | 0 | 0 | 0 | 40.5 | 0.35 | 1 |
| C-103-038 | 3704 | 20 | 88 | 2 | 13 | 0 | 82 | 0.04 | 3 |
| C-103-040 | 3314 | 1 | 55 | 0 | 0 | 0 | 75 | 0.01 | 5 |
| C-103-042 | 2963 | 0 | 0 | 0 | 0 | 0 | 36 | 1.00 | 7 |
| C-103-043 | 4074 | 0 | 2 | 0 | 0 | 0 | 35 | 0.05 | 0 |
| C-103-046 | 3704 | 0 | 46 | 0 | 29 | 0 | 64 | 0.20 | 0 |
| C-103048 | 3889 | 0 | 63 | 65 | 10 | 0 | 32 | 0.01 | 0 |
| C-103-049 | 3241 | 0 | 7 | 0 | 0 | 0 | 180 | 0.10 | 3 |
| C-103-051 | 3334 | 0 | 96 | 0 | 0 | 0 | 32 | 0.00 | 1 |
| C-103-053 | 3889 | 0 | 0 | 13 | 19 | 0 | 50 | 0.00 | 0 |
| C-103-054 | 3797 | 0 | 0 | 0 | 1 | 0 | 17 | 0.00 | 0 |
| C-103-057 | 3889 | 0 | 279 | 0 | 12 | 0 | 70 | 0.01 | 0 |
| C-103-059 | 3704 | 0 | 5 | 0 | 0 | 0 | 61 | 0.00 | 1 |
| C-103-061 | 3704 | 0 | 334 | 59 | 30 | 0 | 75 | 0.25 | 1 |
| C-103-063 | 3704 | 0 | 32 | 0 | 0 | 0 | 10 | 0.00 | 0 |
| C-103-064 | 3704 | 0 | 28 | 3 | 12 | 0 | 26 | 0.00 | 0 |
| C-103-066 | 3704 | 0 | 80 | | 1 | 0 | 15 | 3.20 | 1 |
| C-103-067 | 3704 | 0 | 6 | | 0 | 0 | 28 | 0.00 | 0 |
| C-103-069 | 3704 | 0 | 63 | | 0 | 0 | 12 | 0.00 | 2 |
| C-103-071 | 3704 | 20 | 92 | | 8 | 0 | 37 | 0.00 | 18 |
| C-103-073 | 3704 | 35 | 4 | | 3 | 0 | 20 | 0.15 | 1 |
| C-103-075 | 3704 | 15 | 0 | | 3 | 0 | 13 | 0.00 | 0 |
| C-103-077 | 3704 | 75 | 0 | | 0 | 0 | 15 | 0.00 | 3 |
| C-103-097 | 3704 | 130 | 7 | | | | 15 | 1.25 | |
| C-103-100 | 3704 | 1 | | | | | 18 | 0.00 | |
| C-103-101 | 3704 | 0 | | | | | 30 | | |
| C-103-102 | 3704 | 2150 | | | | | 20 | | |
| C-103-103 | 3704 | 250 | | | | | 2 | | |
| C-103-104 | 3704 | 1700 | | | | | | | |
| C-103-106 | 3704 | 10 | | | | | 21 | | |
| C-103-107 | 3704 | 135 | | | | | 13 | | |

**Sarg. - *Sargassum***
**Halo. - *Halobates***
**Lepto. - Leptocephali**
**Myc. - Myctophids**
**Phyl. - Phyllosoma**

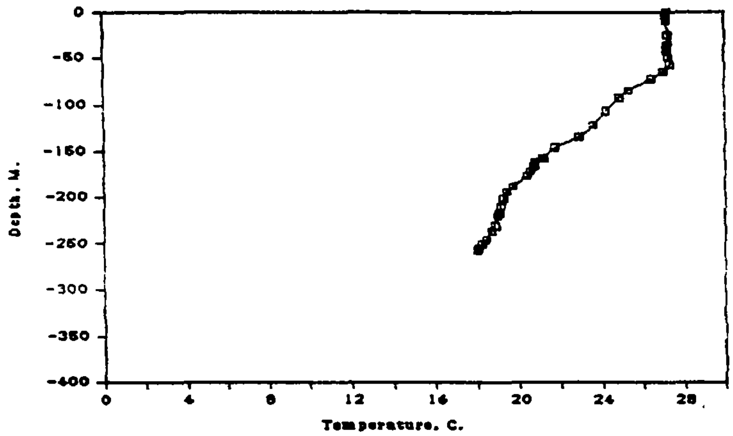
## 4.4 Appendix D - Electronic Bathythermograph Stations

| Station | Date | Time | Log (nm.) | Lat N. | Long W. | Surface Temp °C. |
|---|---|---|---|---|---|---|
| BT-001 | 02-Dec-88 | 2130 | | 18°12 | 64°55 | 27.5 |
| BT-002 | 03-Dec-88 | 1631 | 59.9 | 18°13 | 64°39 | 27.6 |
| BT-003 | 04-Dec-88 | 0210 | 117.8 | 17°58 | 63°40 | 27.5 |
| BT-004 | 04-Dec-88 | 2230 | 172.7 | 17°17 | 63°37 | 27.1 |
| BT-005 | 05-Dec-88 | 0047 | 183.4 | 17°08 | 63°47 | 27.6 |
| BT-006 | 05-Dec-88 | 0417 | 196.7 | 16°56 | 63°25 | 27.6 |
| BT-007 | 05-Dec-88 | 0610 | 203.0 | 16°52 | 63°21 | 27.5 |
| BT-008 | 05-Dec-88 | 0900 | 212.9 | 16°24 | 63°20 | 27.6 |
| BT-009 | 06-Dec-88 | 0515 | 300.5 | 16°04 | 62°16 | 27.4 |
| BT-010 | 06-Dec-88 | 1620 | 328.3 | 15°35 | 62°04 | 28.1 |
| BT-011 | 07-Dec-88 | 0120 | 362.5 | 15°05 | 61°44 | 28.0 |
| BT-012 | 07-Dec-88 | 0919 | 390.1 | 14°35 | 61°32 | 27.6 |
| BT-013 | 07-Dec-88 | 1435 | 404.0 | 14°13 | 61°28 | 27.5 |
| BT-014 | 07-Dec-88 | 1854 | 425.0 | 13°58 | 61°25 | 27.5 |
| BT-015 | 08-Dec-88 | 0610 | 464.8 | 13°26 | 61°29 | 27.7 |
| BT-016 | 13-Dec-88 | 0600 | 611.8 | 13°01 | 62°18 | 27.2 |
| BT-017 | 13-Dec-88 | 1800 | 662.9 | 12°29 | 63°21 | 27.1 |
| BT-018 | 14-Dec-88 | 0600 | 726.7 | 12°20 | 64°22 | 27.4 |
| BT-019 | 14-Dec-88 | 1806 | 729.3 | 12°24 | 65.28 | 27.6 |
| BT-020 | 15-Dec-88 | 0610 | 836.6 | 12°39 | 66°45 | 26.0 |
| BT-021 | 15-Dec-88 | 1800 | 898.8 | 12°22 | 67°35 | 27.6 |
| BT-027 | 21-Dec-88 | 1800 | 1319.5 | 16°33 | 73°01 | 27.6 |
| BT-028 | 22-Dec-88 | 0600 | 1395.5 | 17°02 | 74°22 | 27.6 |
| BT-029 | 22-Dec-88 | 1800 | 1449.5 | 17°28 | 75°15 | 27.7 |
| BT-030 | 23-Dec-88 | 0600 | 1515.2 | 17°22 | 76°28 | 27.6 |
| BT-031 | 23-Dec-88 | 1818 | 1577.7 | 17°23 | 77°32 | 27.3 |
| BT-032 | 26-Dec-88 | 1810 | 1774.6 | 16°25 | 81°29 | 27.5 |
| BT-033 | 27-Dec-88 | 1800 | 1893.2 | 16°38 | 83°18 | 27.6 |
| BT-034 | 28-Dec-88 | 0000 | 1919.3 | 16°30 | 84°21 | 26.8 |
| BT-035 | 28-Dec-88 | 0600 | 1943.3 | 16°28 | 84°49 | 27.2 |
| BT-036 | 28-Dec-88 | 1700 | 1984.1 | 16°27 | 85°43 | 26.8 |
| BT-037 | 29-Dec-88 | 0102 | 2023.6 | 16°20 | 85°59 | 26.8 |
| BT-038 | 29-Dec-88 | 0600 | 2042.8 | 16°19 | 86.21 | 26.9 |
| BT-045 | 03-Jan-89 | 1234 | 2254.6 | 19°28 | 86°03 | 27.0 |
| BT-046 | 03-Jan-89 | 1800 | 2275.3 | 19°53 | 86°13 | 27.4 |
| BT-047 | 04-Jan-89 | 0000 | 2304.2 | 20°27 | 86°20 | 27.3 |
| BT-048 | 04-Jan-89 | 0600 | 2331.6 | 21°00 | 86°31 | 26.8 |
| BT-048 | 04-Jan-89 | 0615 | 2333.5 | 21°00 | 86°32 | 26.8 |
| BT-049 | 04-Jan-89 | 1800 | 2381.3 | 21°47 | 86°04 | 27.3 |
| BT-050 | 05-Jan-89 | 0000 | 2409.0 | 21°53 | 85°41 | 27.0 |
| BT-051 | 05-Jan-89 | 1800 | 2466.2 | 22°79 | 86°14 | 26.7 |

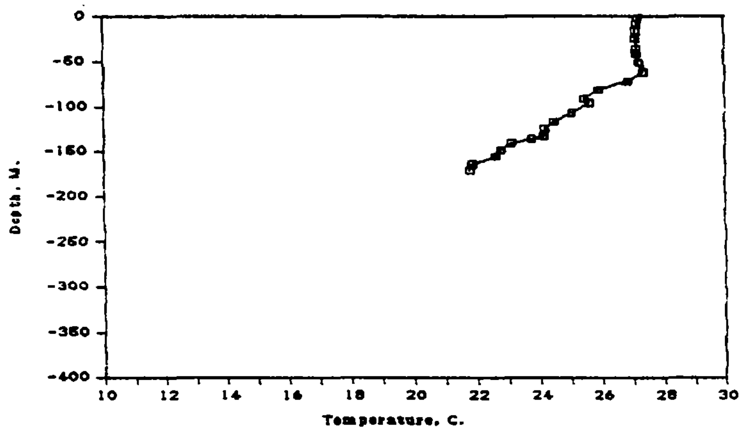
| | | | | | | |
|---|---|---|---|---|---|---|
| BT-052 | 06-Jan-89 | 0000 | 2510.4 | 23°03 | 85°52 | 26.6 |
| BT-053 | 06-Jan-89 | 0600 | 2557.5 | 23°07 | 85°02 | 26.2 |
| BT-054 | 06-Jan-89 | 1200 | 2583.0 | 23°21 | 84°24 | 26.5 |
| BT-055 | 06-Jan-89 | 1800 | 2588.9 | 23°31 | 84°09 | 25.7 |
| BT-056 | 07-Jan-89 | 0000 | 2607.9 | 23°53 | 83°58 | 23.9 |
| BT-057 | 07-Jan-89 | 0600 | 2640.6 | 24°40 | 83°40 | 27.7 |
| BT-058 | 07-Jan-89 | 1800 | 2700.5 | 25°06 | 83°28 | 24.7 |
| BT-059 | 08-Jan-89 | 0000 | 2739.3 | 23°34 | 83°09 | 26.0 |
| BT-060 | 08-Jan-89 | 0600 | 2770.9 | 23°48 | 82°44 | 26.3 |
| BT-061 | 08-Jan-89 | 1200 | 2799.6 | 24°03 | 82°20 | 26.4 |
| BT-062 | 08-Jan-89 | 1800 | 2830.6 | 23°37 | 82°20 | 26.2 |
| BT-063 | 09-Jan-89 | 0000 | 2867.4 | 24°11 | 81°34 | 26.3 |
| BT-064 | 09-Jan-89 | 1200 | 2930.0 | 24°13 | 80°50 | 26.0 |
| BT-065 | 09-Jan-89 | 2123 | 3029.3 | 24°35 | 80°20 | 25.3 |

## 4.5 Appendix E - Electronic Bathythermograph Temperature-Depth Profiles

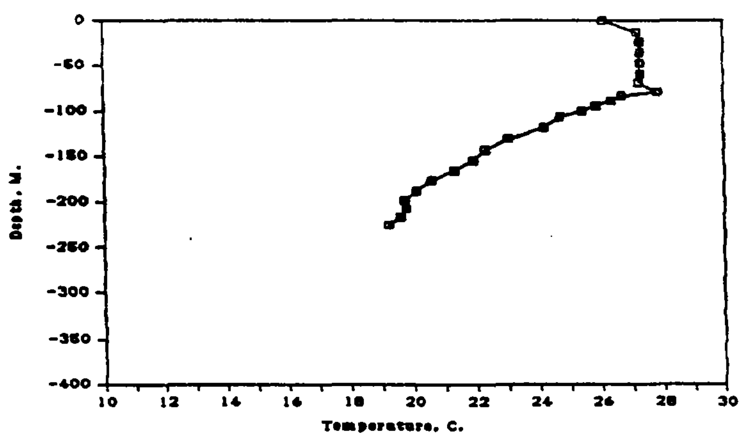
## EBT Number: 001

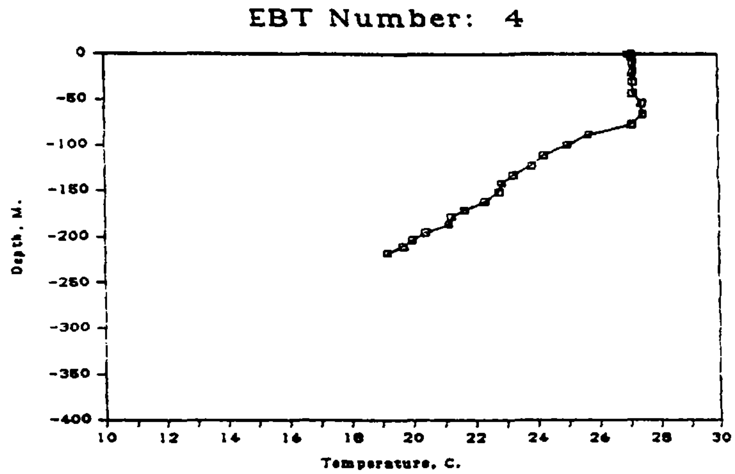


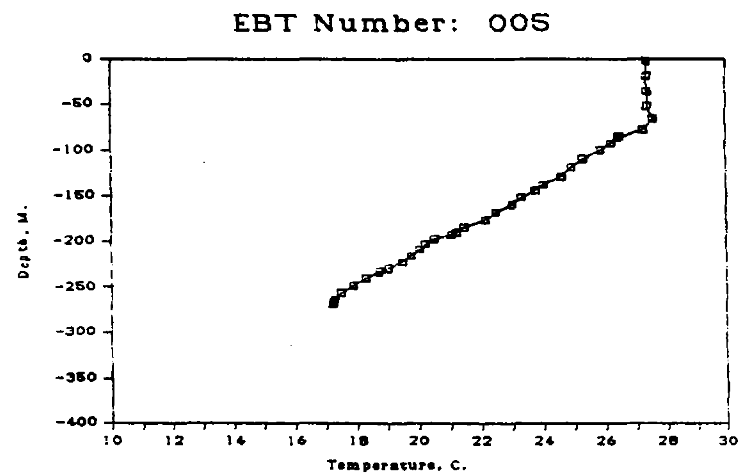

## EBT Number: 002

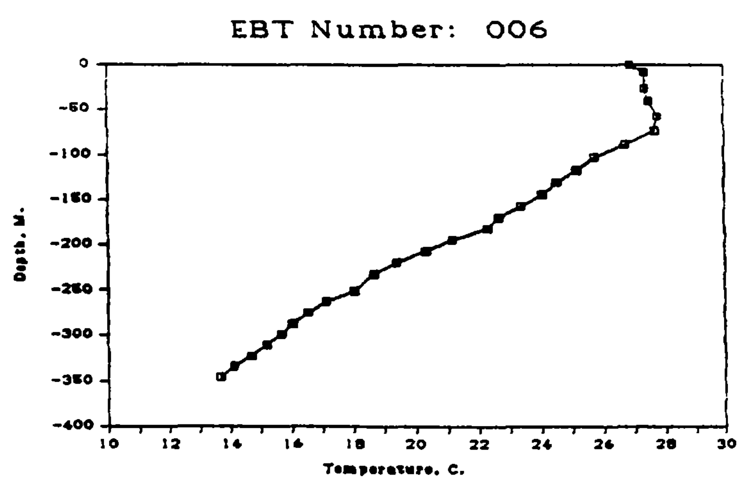



## EBT Number: 003

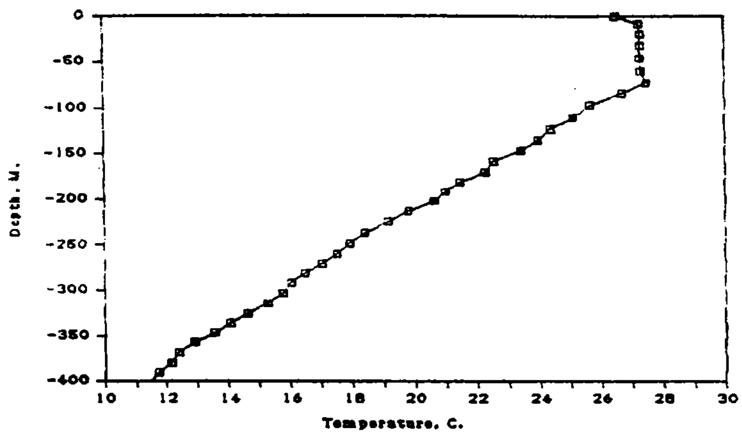



EBT Number: 4
Depth, M.
Temperature, C.

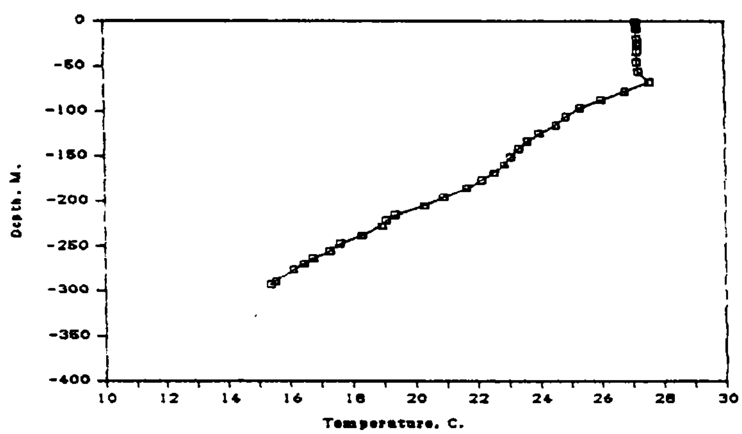

EBT Number: 005
Depth, M.
Temperature, C.


EBT Number: 006
Depth, M.
Temperature, C.

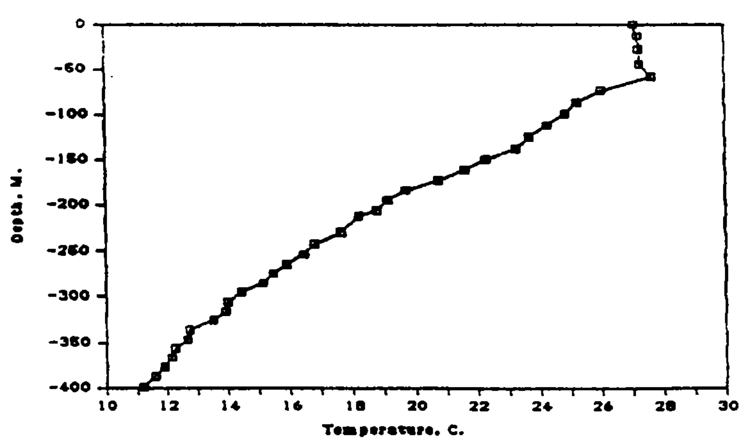
EBT Number: 007



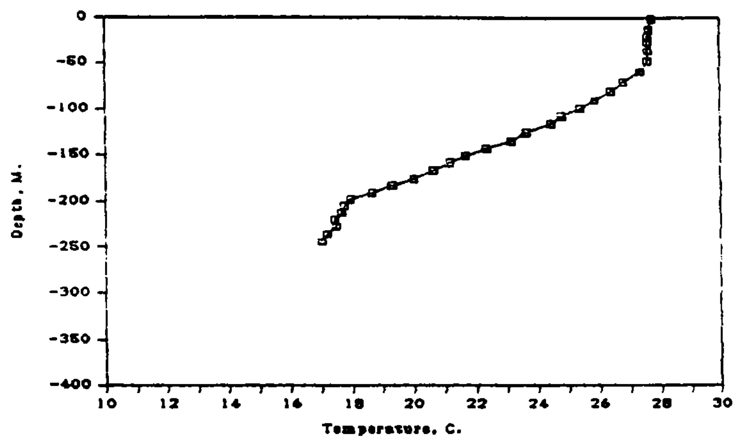

EBT Number: 008



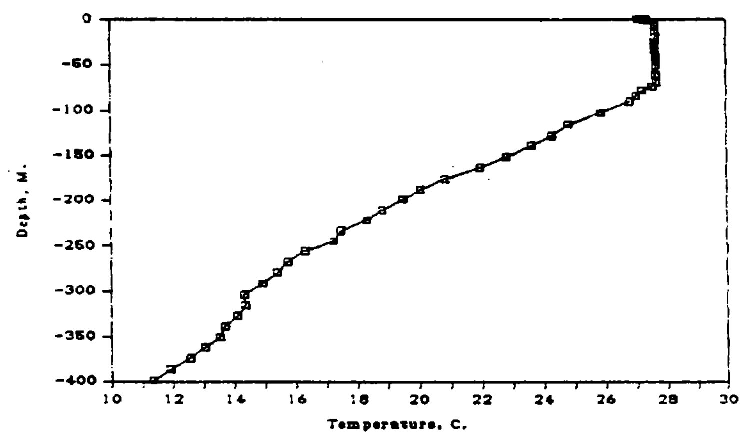

EBT Number: 009



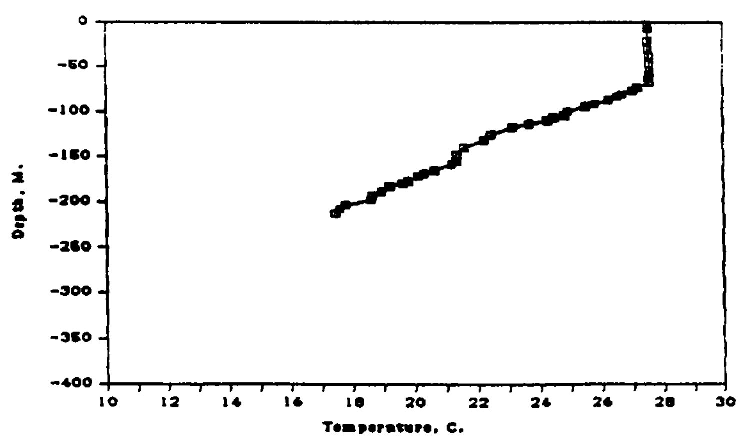
EBT Number: 010



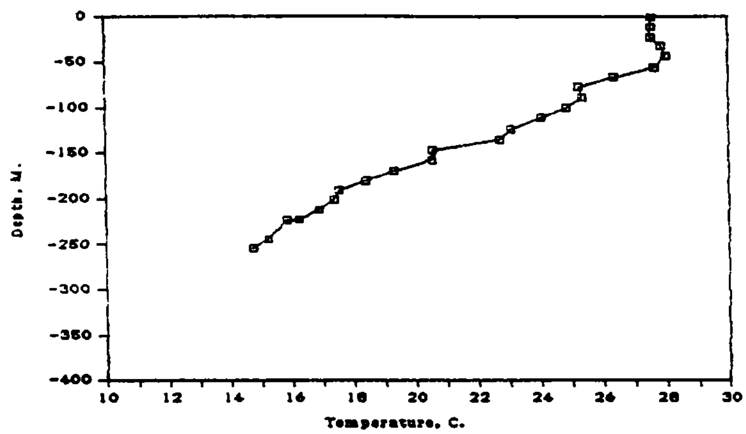

EBT Number: 011



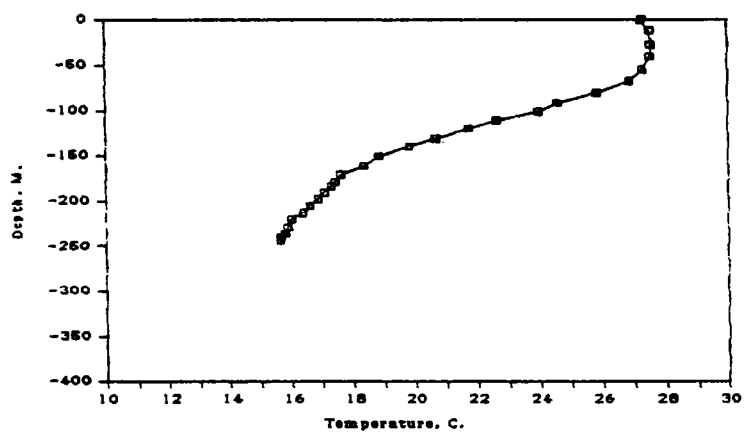

EBT Number: 012



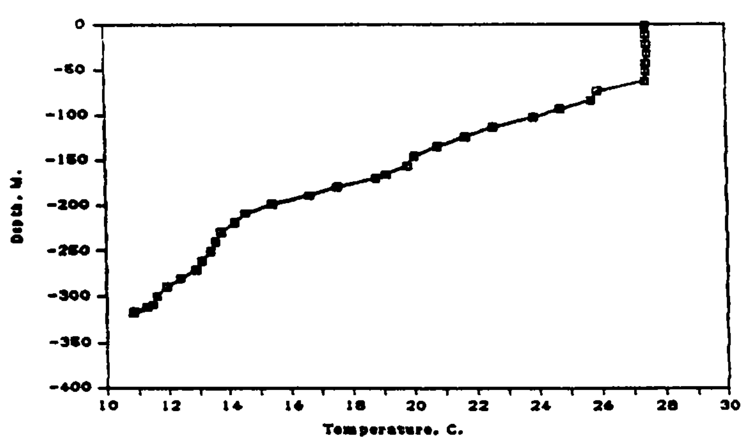
## EBT Number: 013



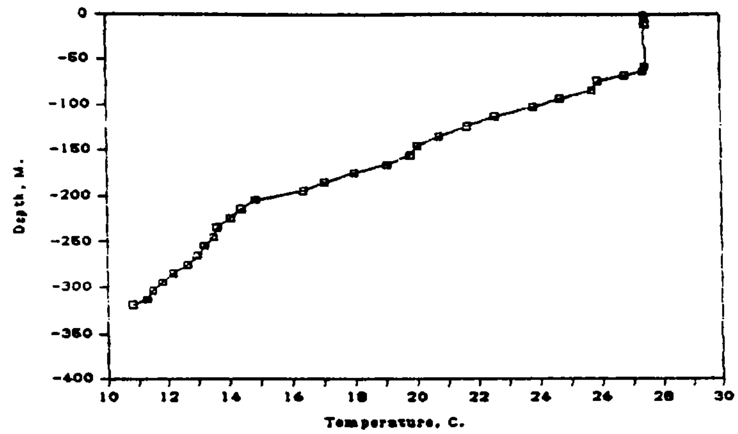

## EBT Number: 014



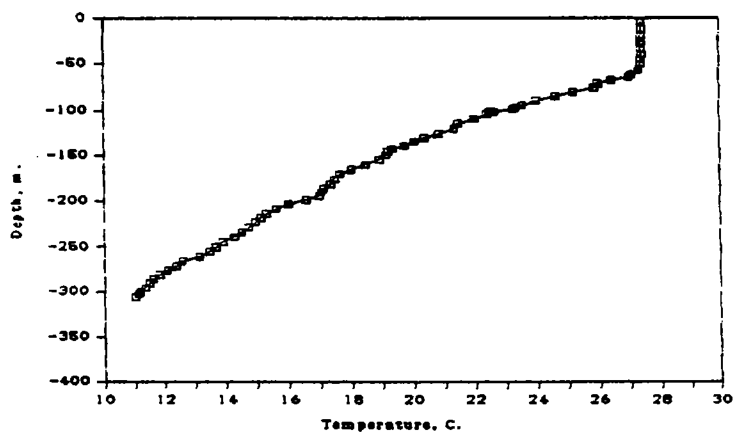

## EBT Number: 015



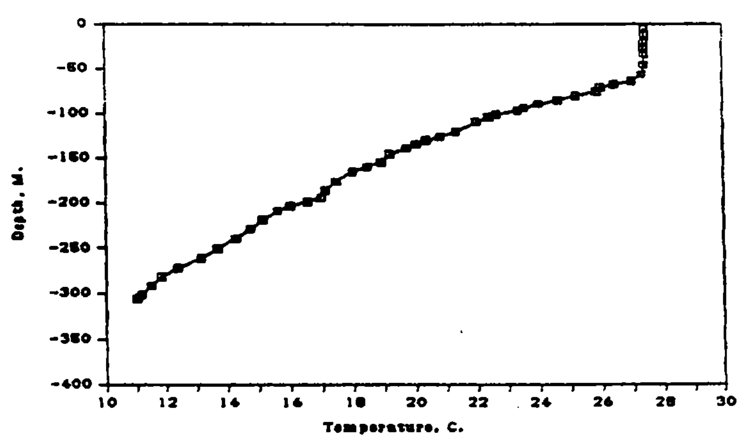
EBT Number: 016

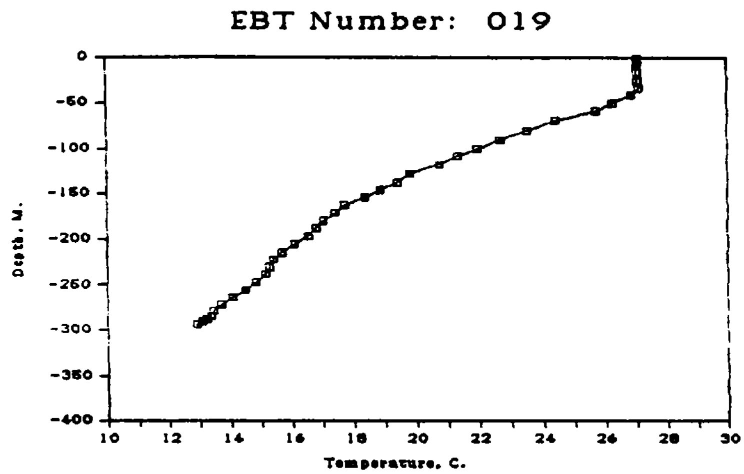


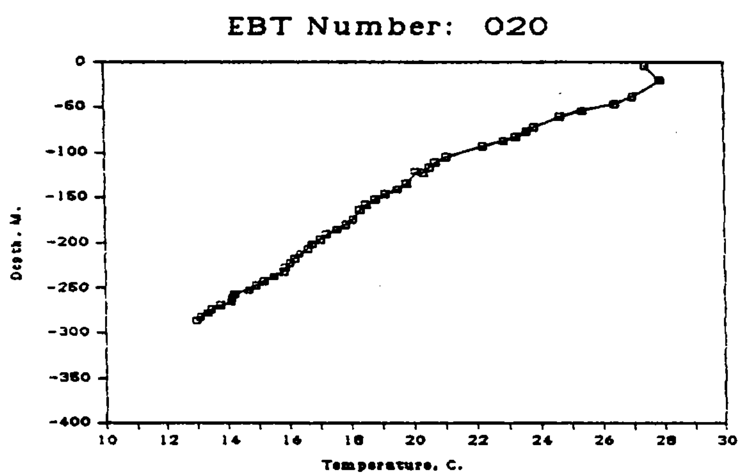

EBT: 017




EBT Number: 018




EBT Number: 019
Depth, M.
Temperature, C.
0
-50
-100
-150
-200
-250
-300
-350
-400
10
12
14
16
18
20
22
24
26
28
30


EBT Number: 020
Depth, M.
Temperature, C.
0
-50
-100
-150
-200
-250
-300
-350
-400
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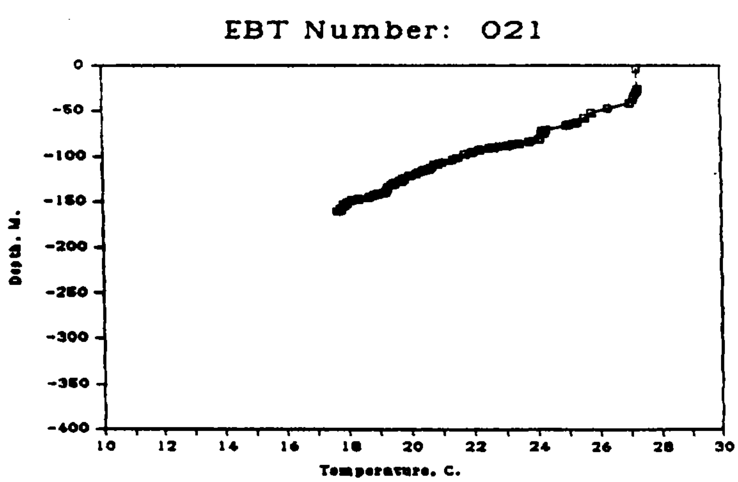
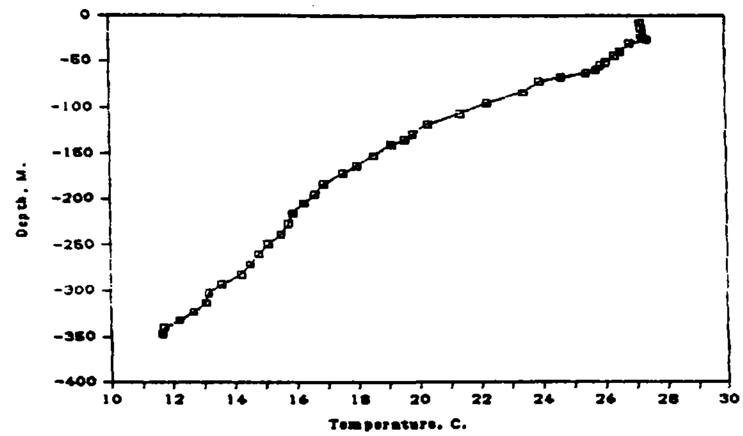
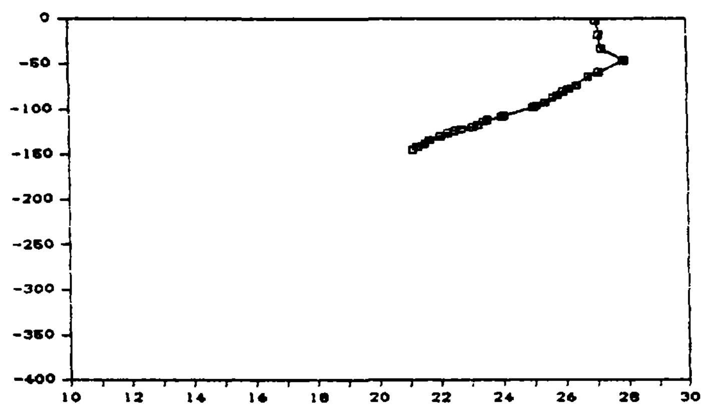
12
14
16
18
20
22
24
26
28
30


EBT Number: 021
Depth, M.
Temperature, C.
0
-50
-100
-150
-200
-250
-300
-350
-400
10
12
14
16
18
20
22
24
26
28
30

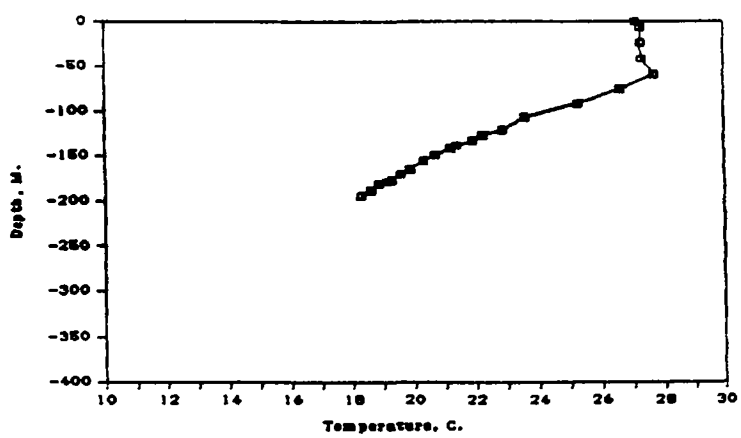
EBT Number: 022



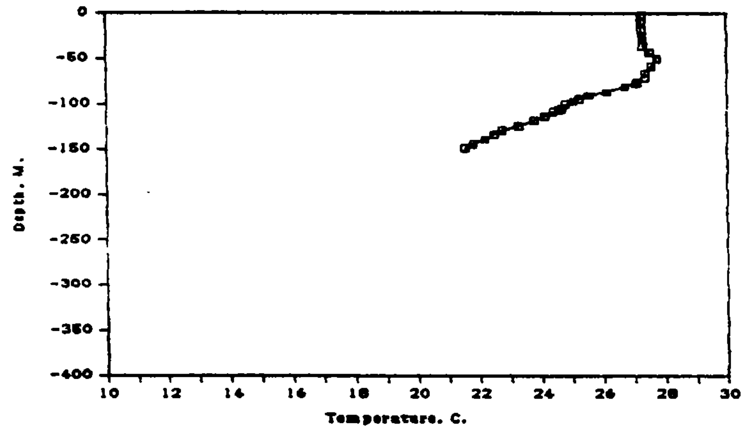

EBT-023



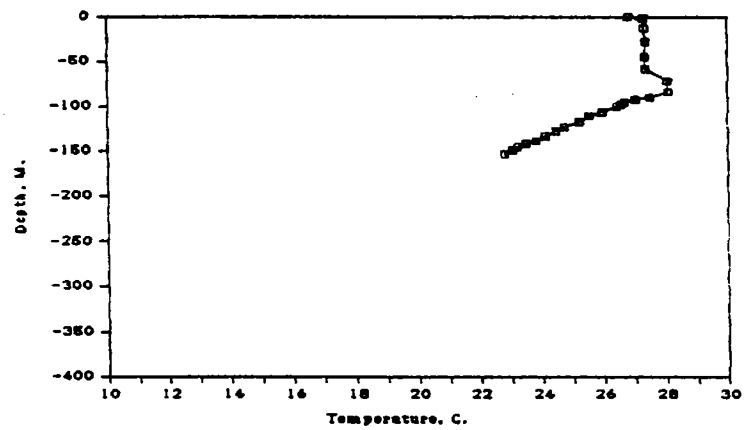

EBT Number: 024



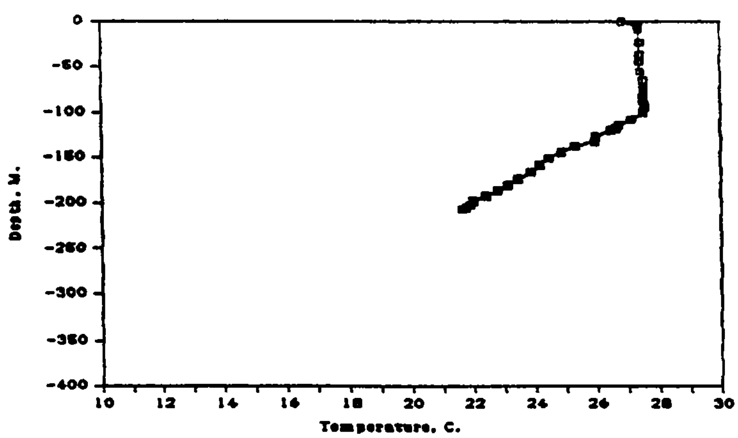
## EBT Number: 025




## EBT Number: 27




## EBT Number: 028



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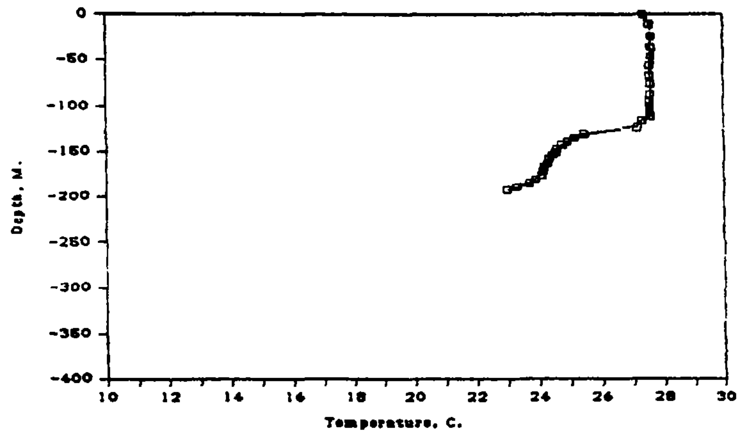


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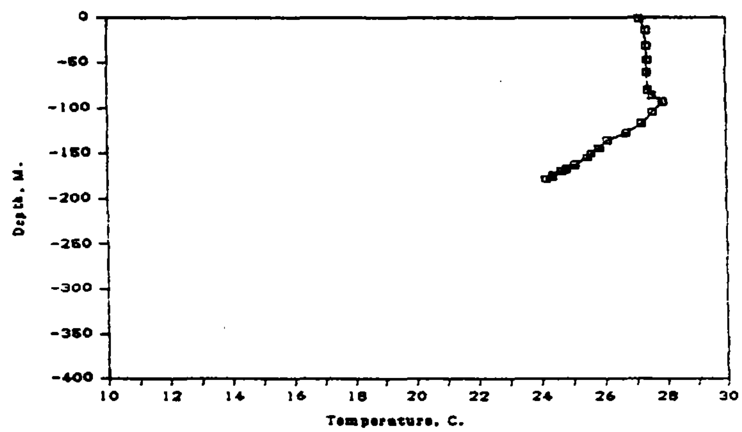


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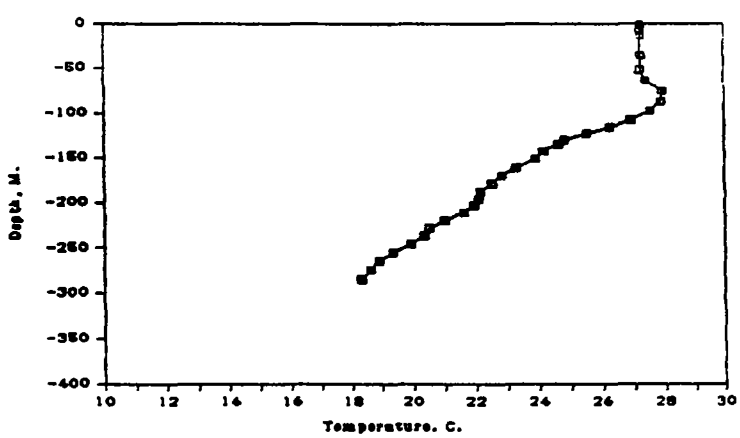

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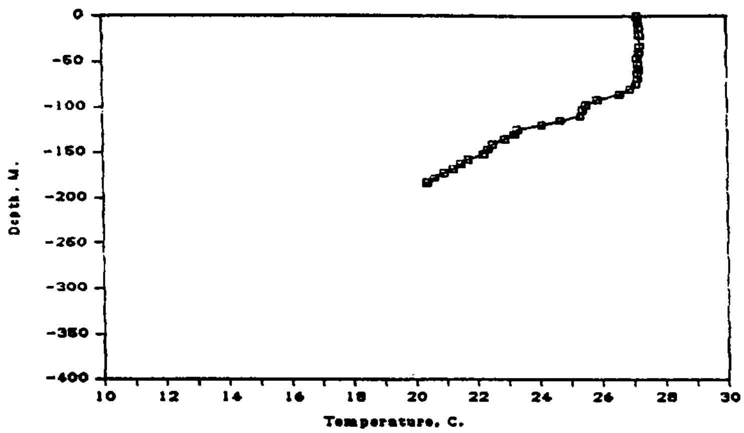


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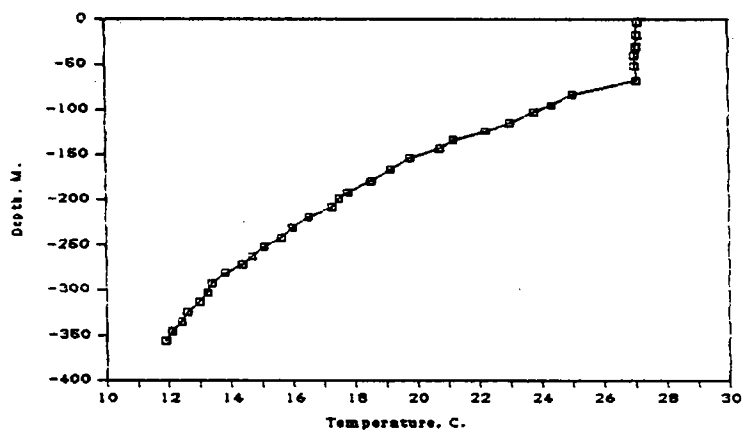


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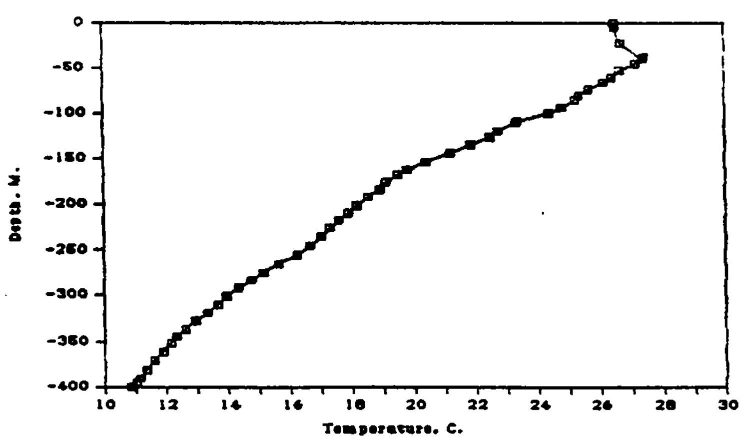

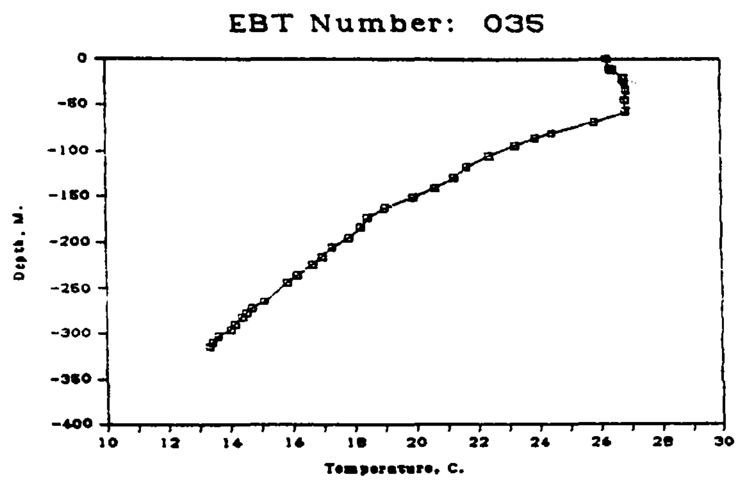
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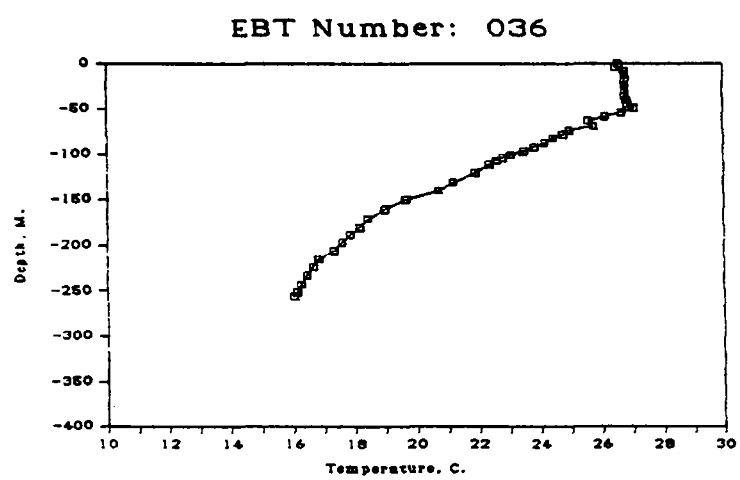
0
-50
-100
-150
-200
-250
-300
-350
-400
Depth, M.
10
12
14
16
18
20
22
24
26
28
30
Temperature, C.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0
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-100
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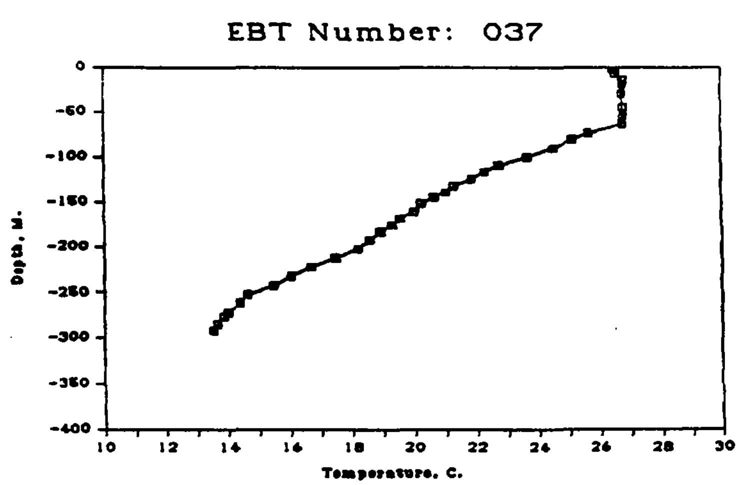
-200
-250
-300
-350
-400
Depth, M.
10
12
14
16
18
20
22
24
26
28
30
Temperature, C.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-50
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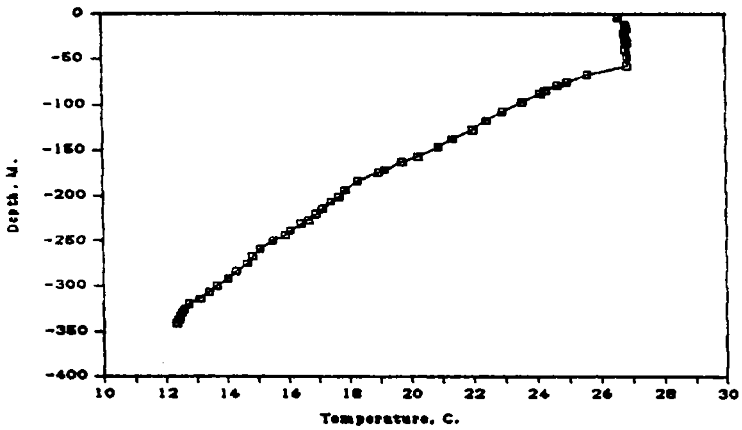
-150
-200
-250
-300
-350
-400
Depth, M.
10
12
14
16
18
20
22
24
26
28
30
Temperature, C.

EBT Number: 038

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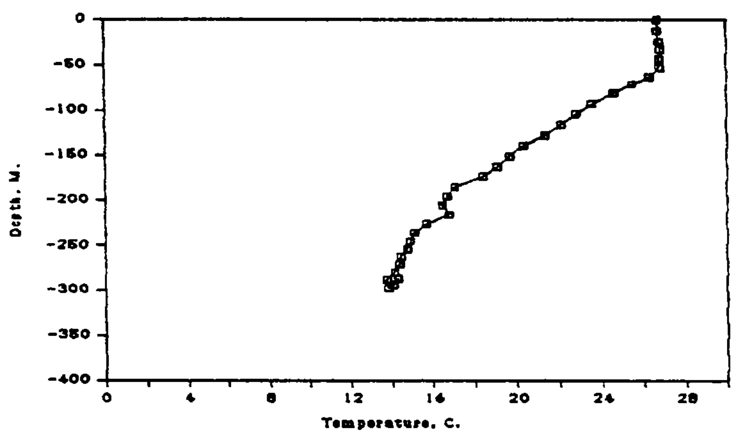


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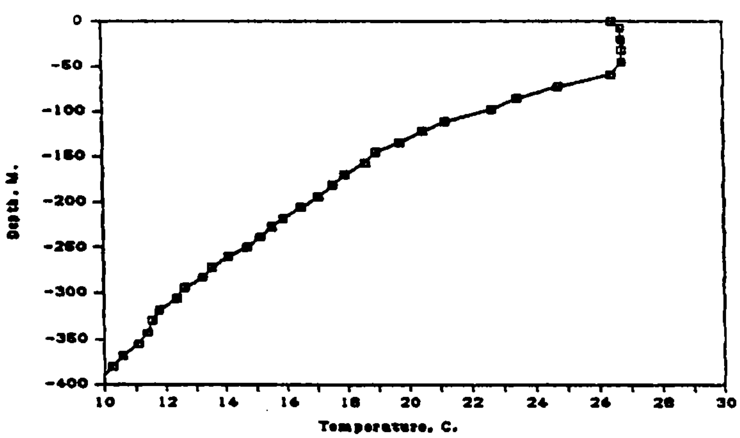

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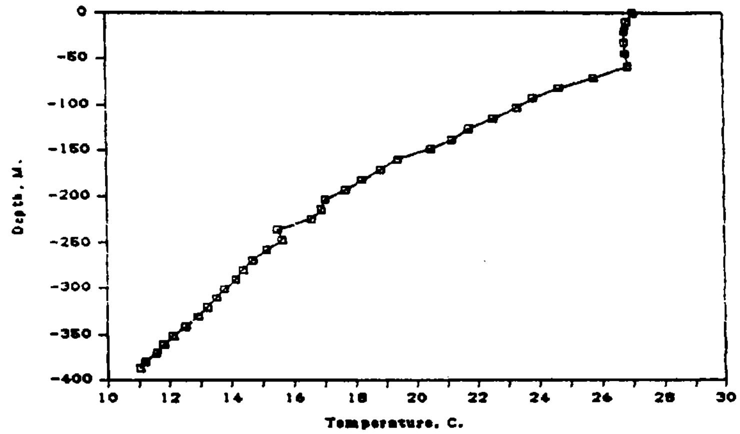
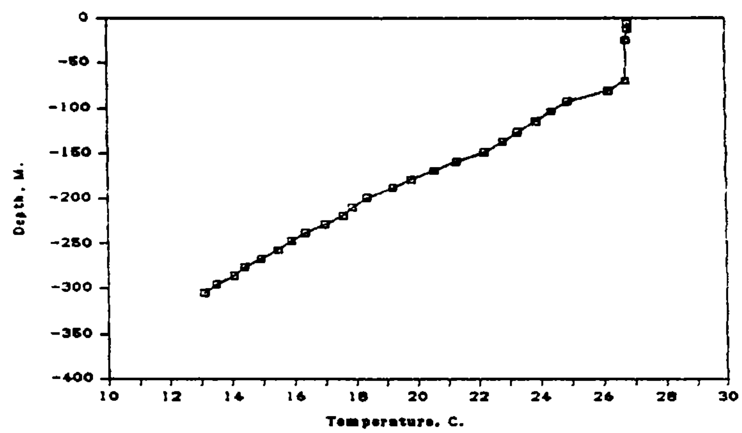



## EBT Number: 042

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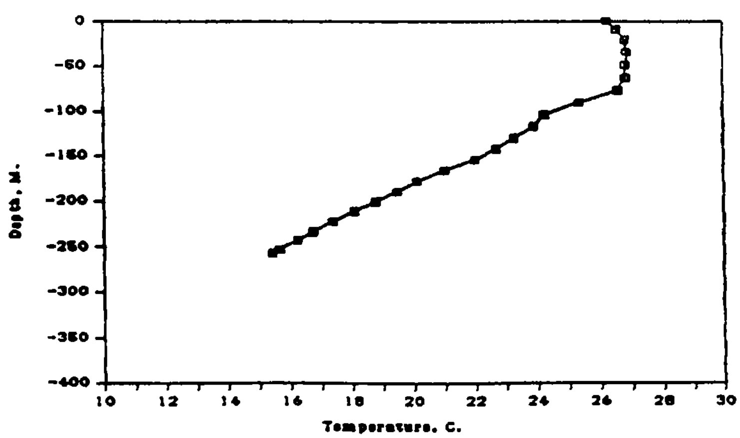

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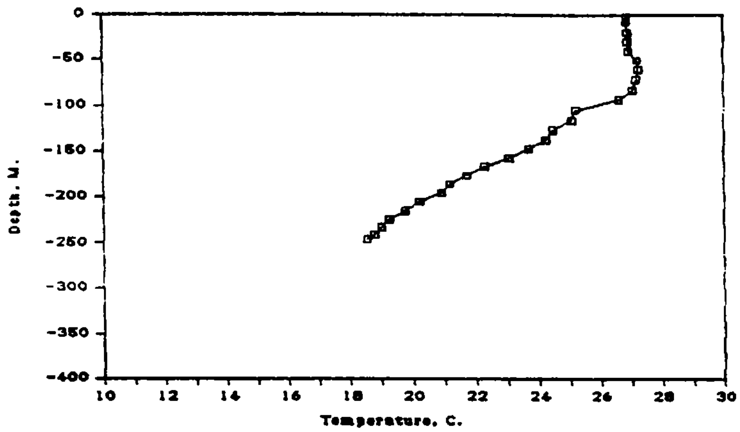
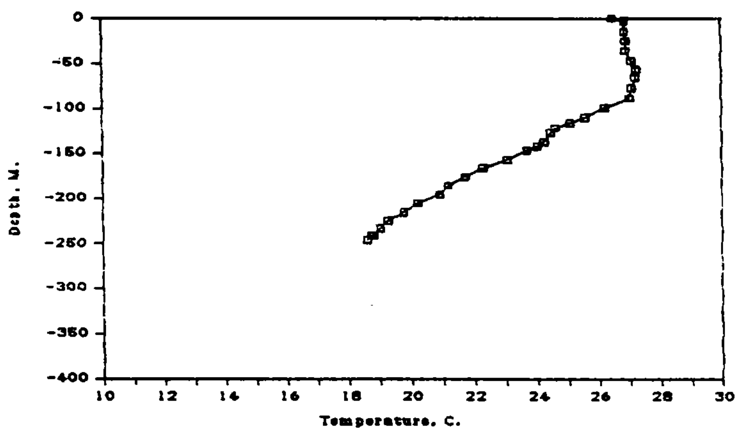
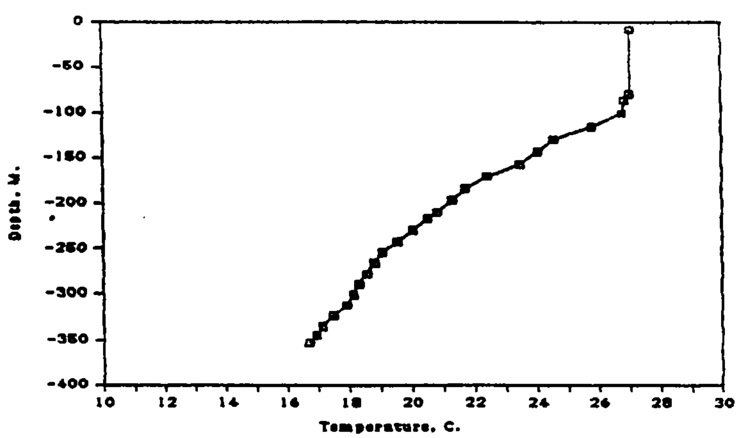



## EBT Number: 045




## EBT Number: 046



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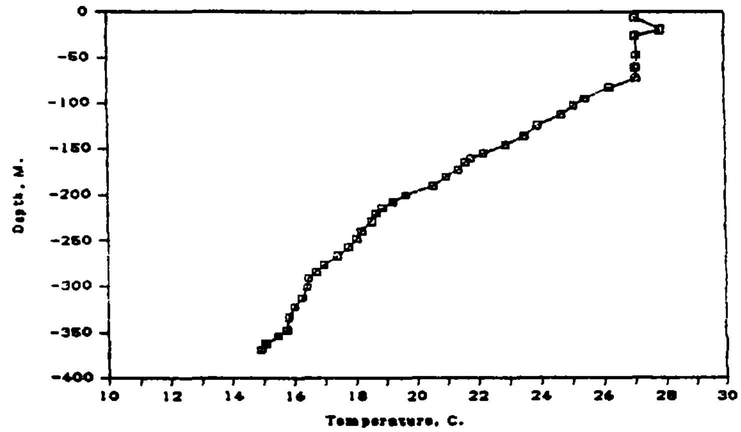


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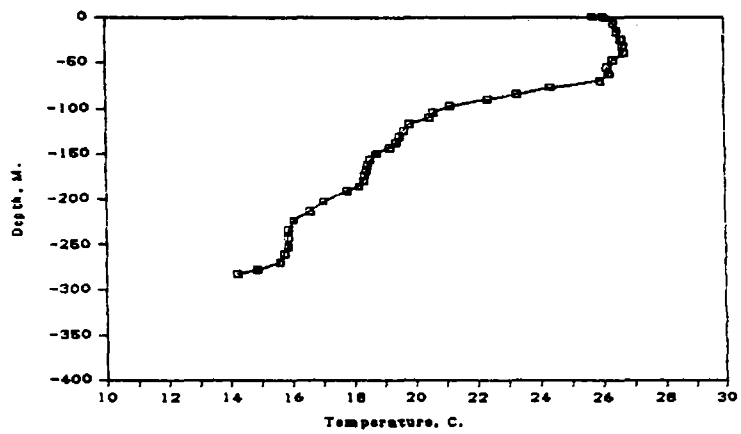


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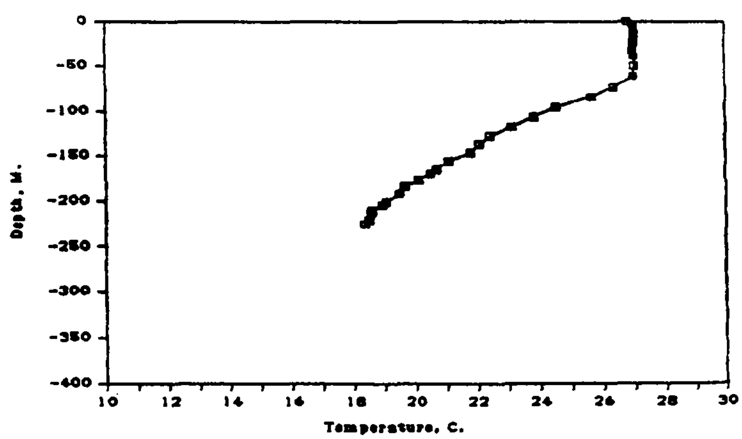

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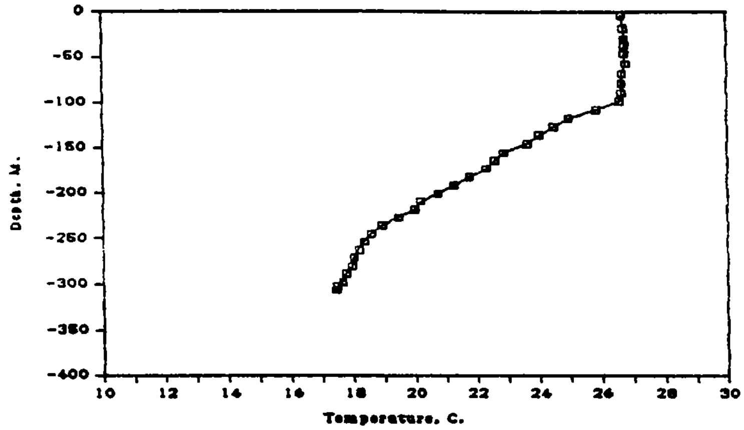
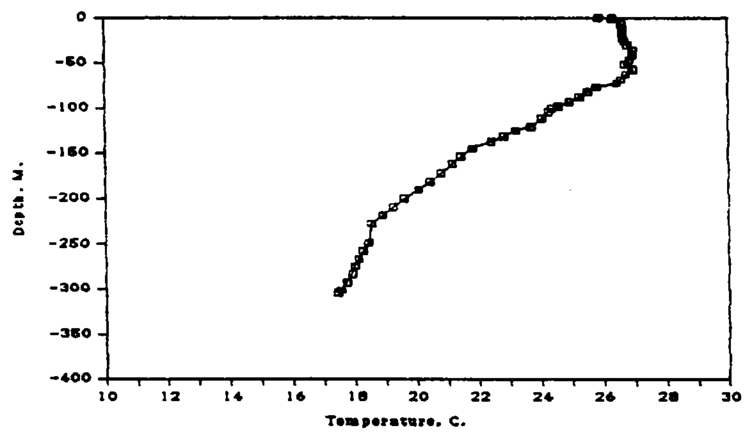



EBT Number: 051

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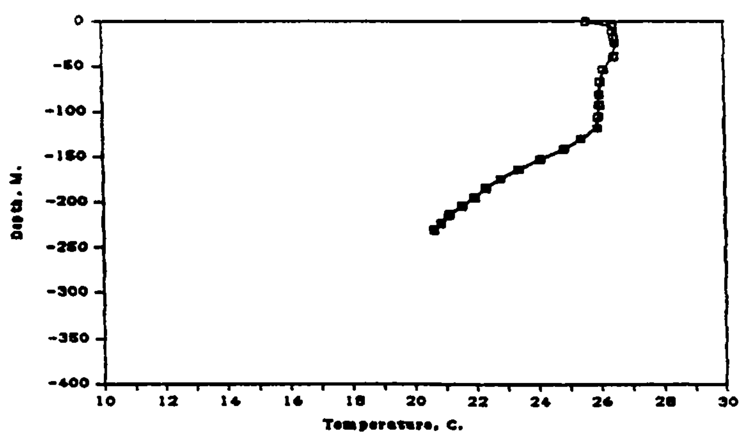

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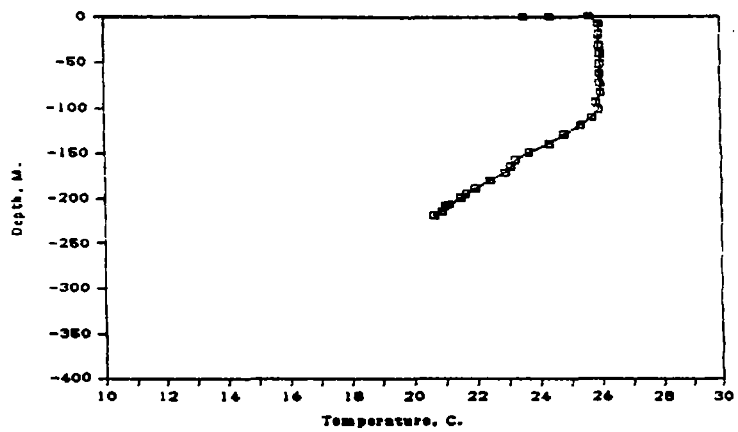


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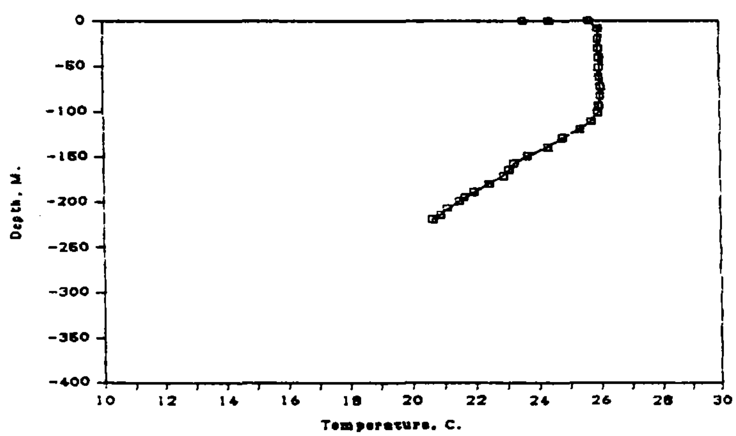


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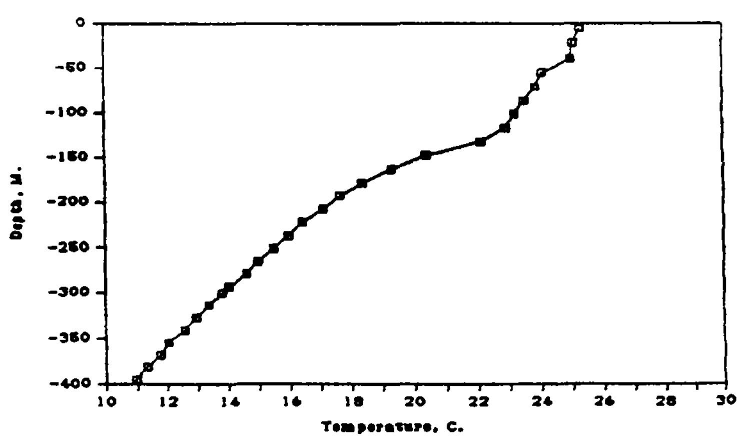

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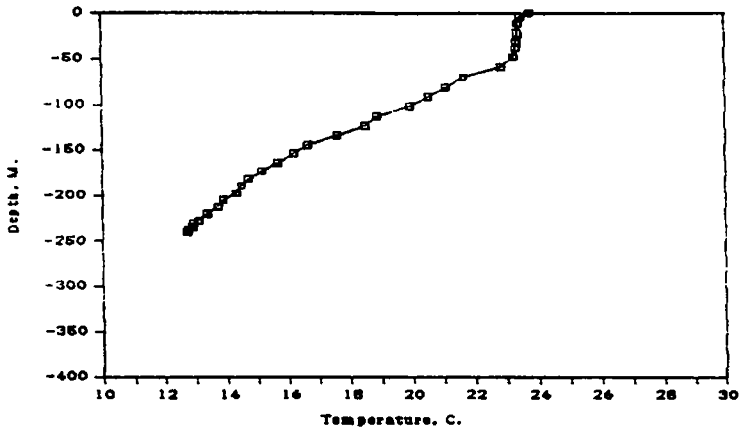


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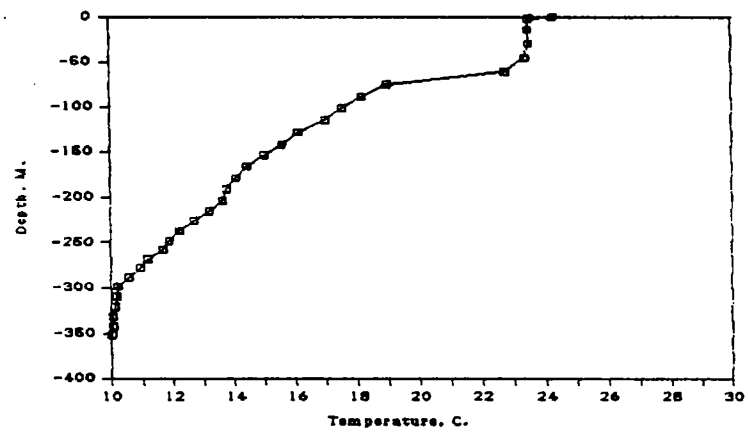
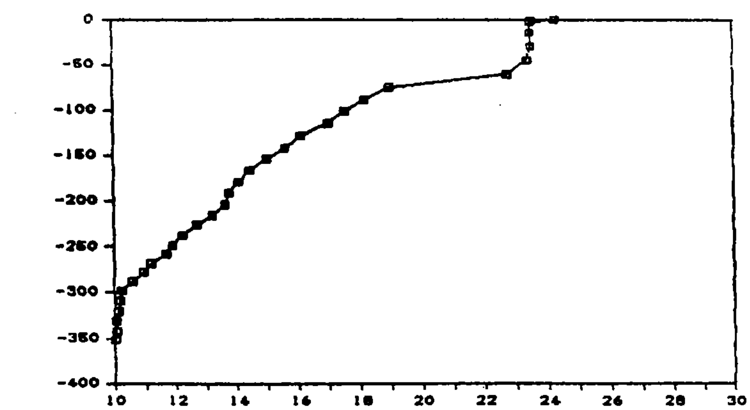



EBT-058



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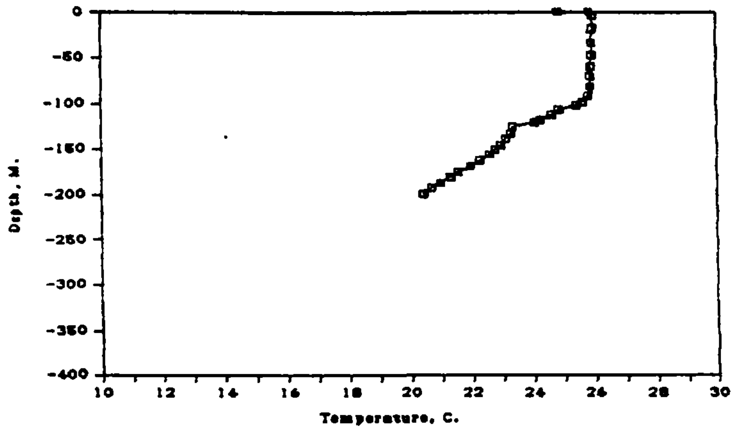


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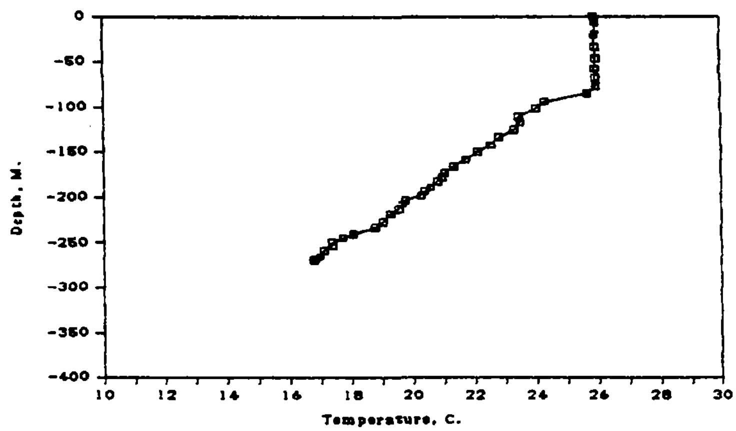
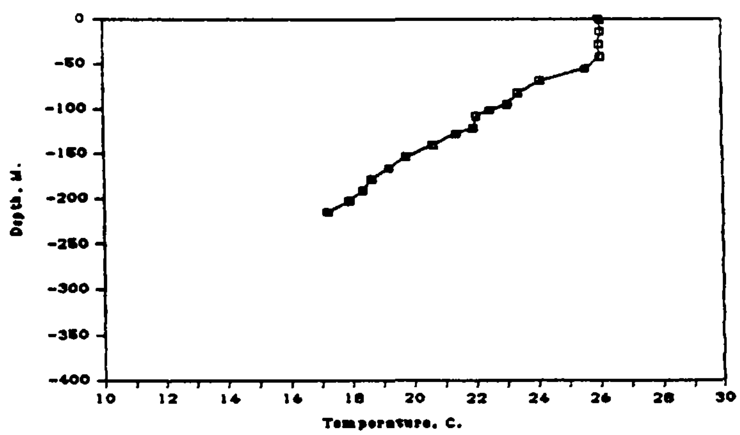
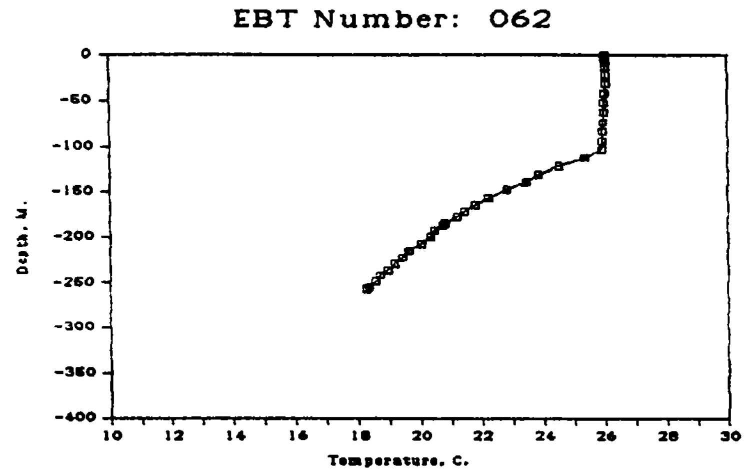



EBT Number: 061

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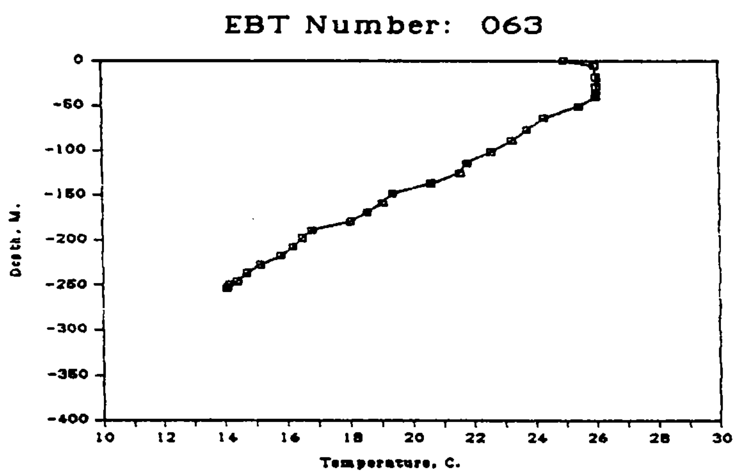
Temperature, C.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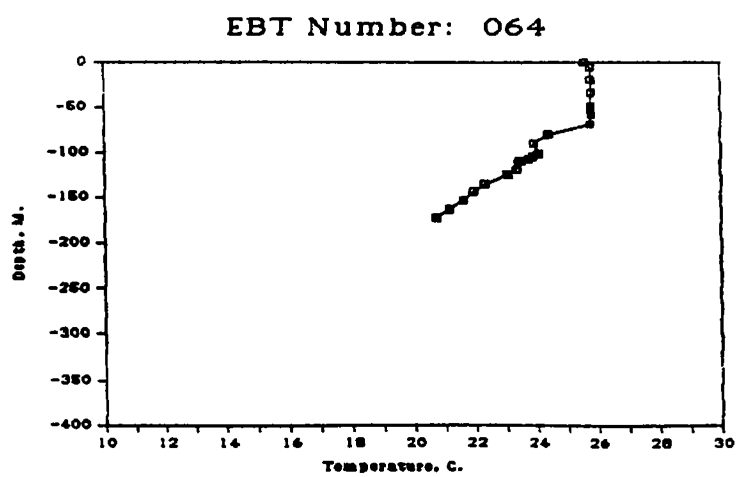
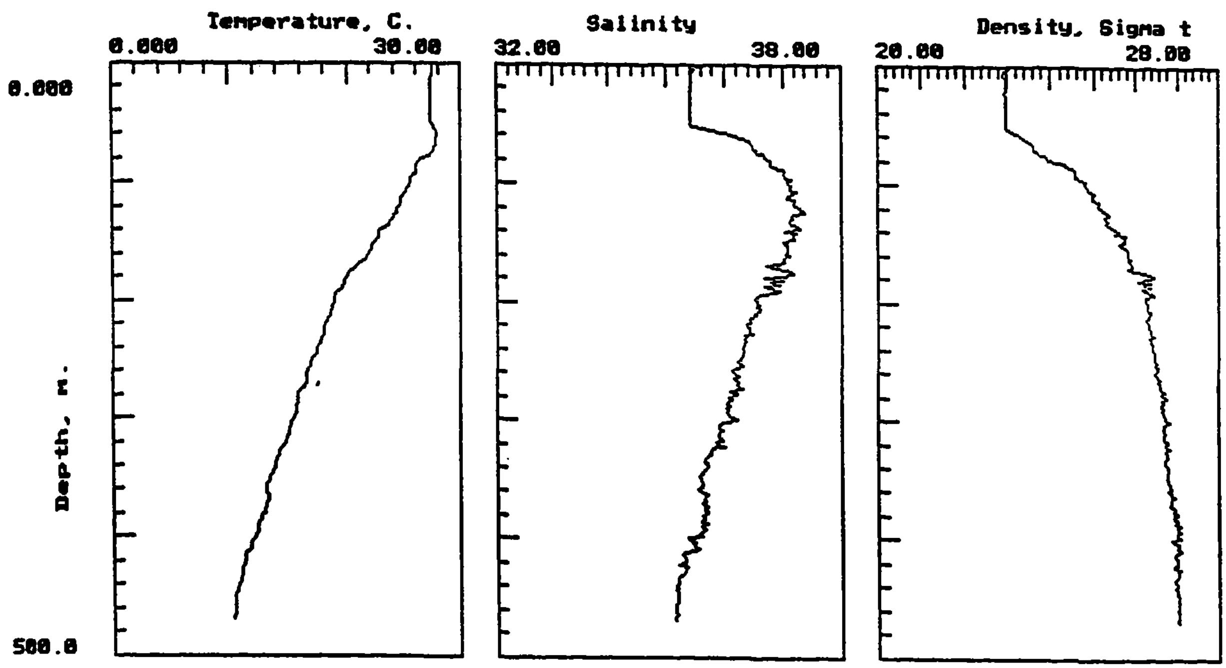
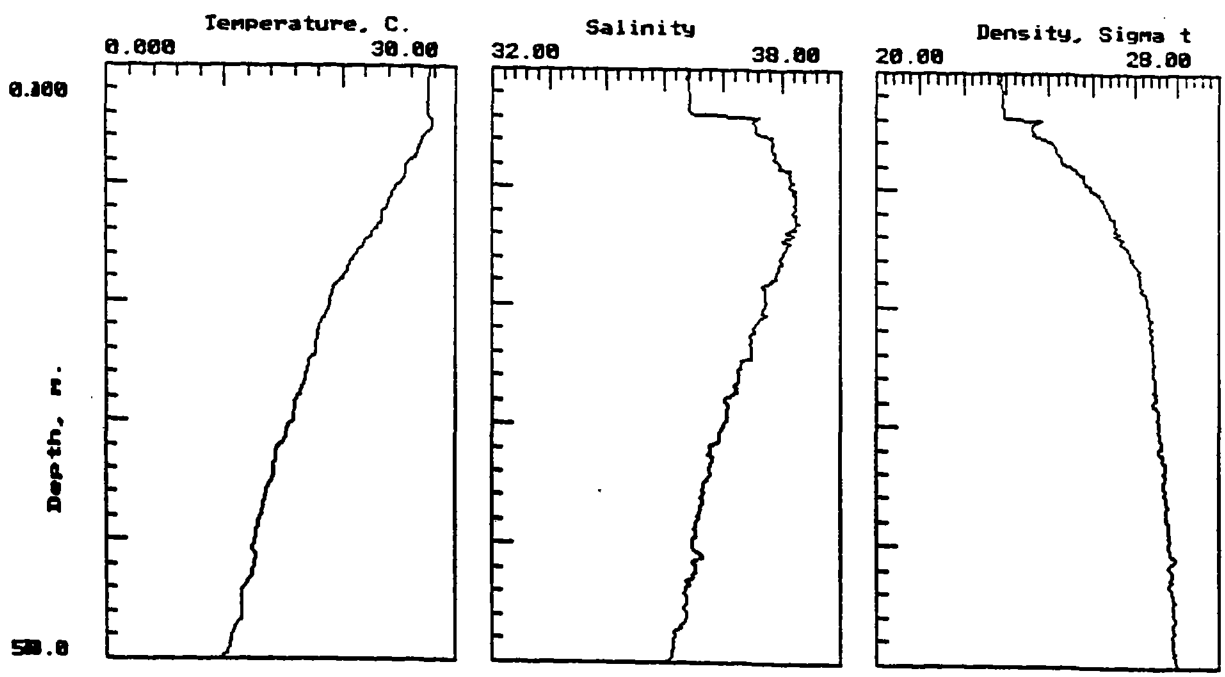
Temperature, C.


EBT Number: 064
Depth, M.
Temperature, C.

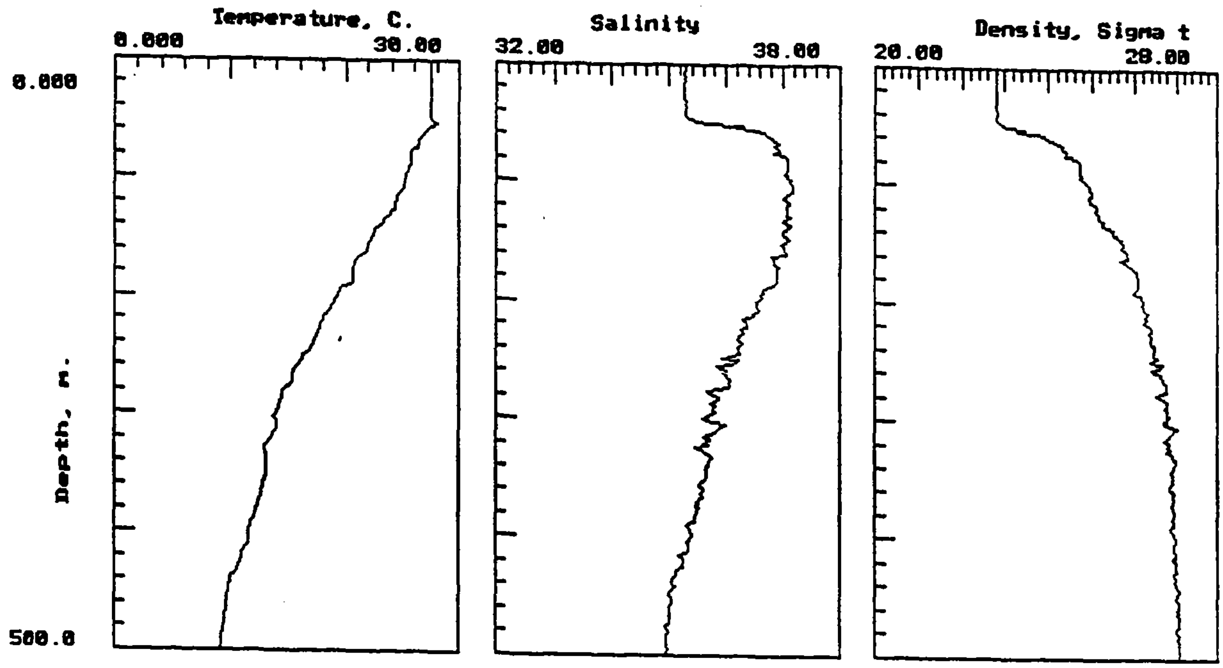
## 4.6 Appendix F - CTD Temperature, Salinity and Density Profiles



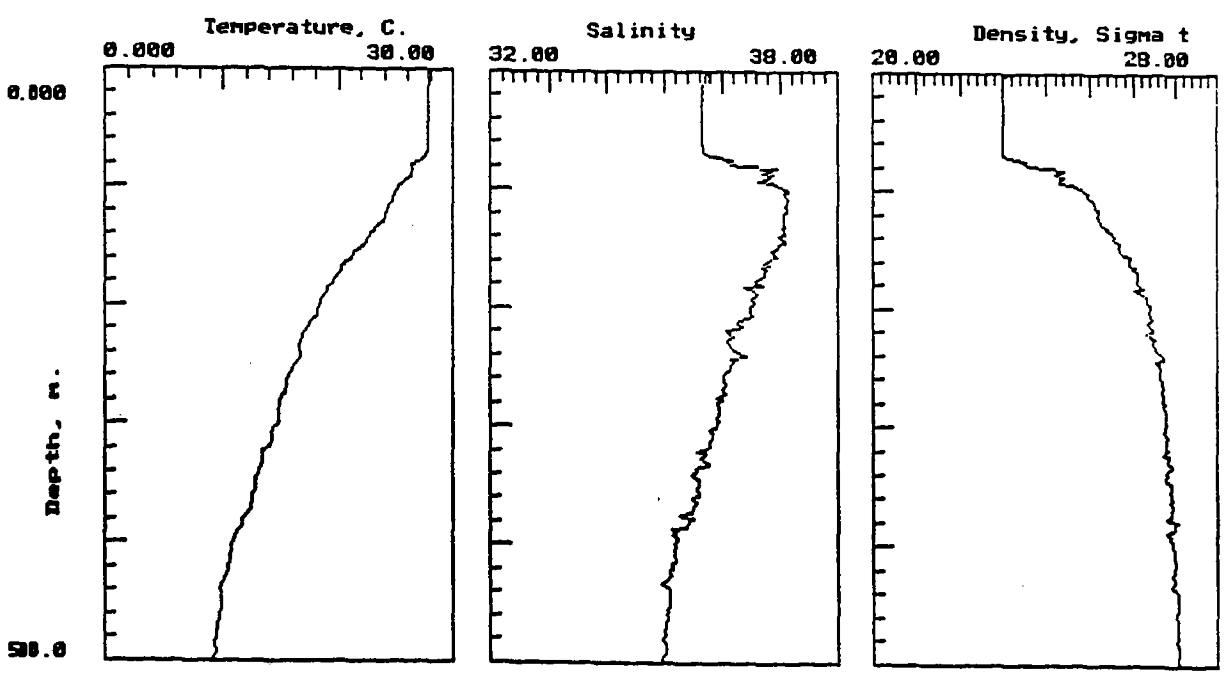

C-103-031



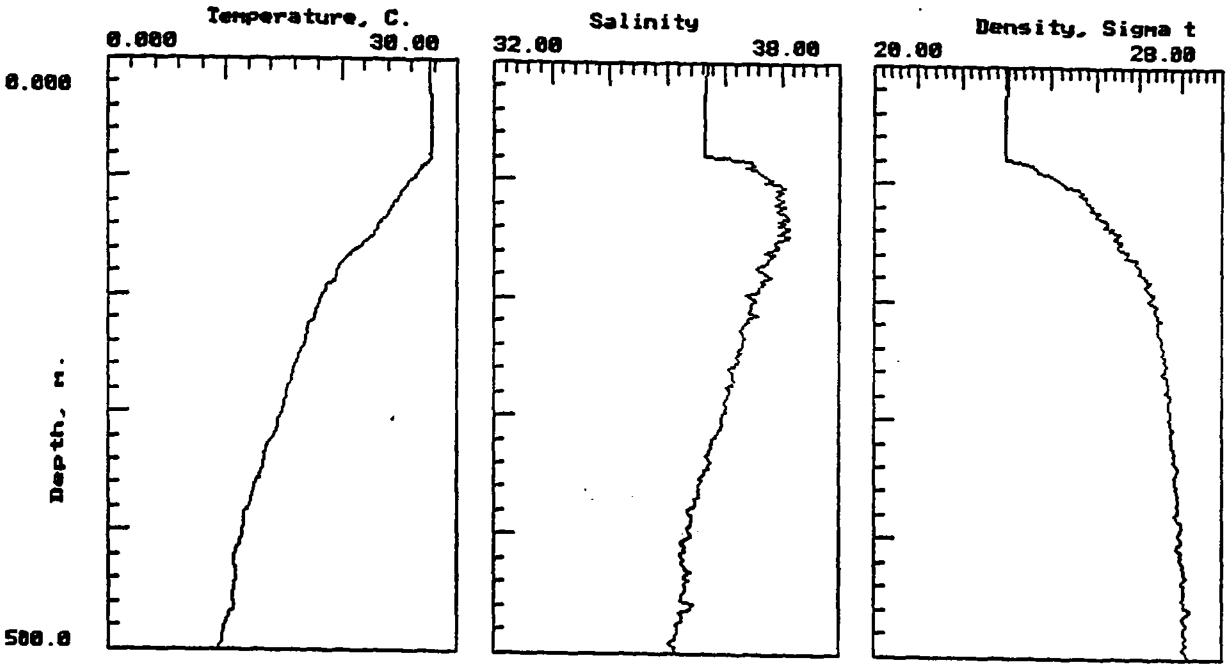

C-103-032



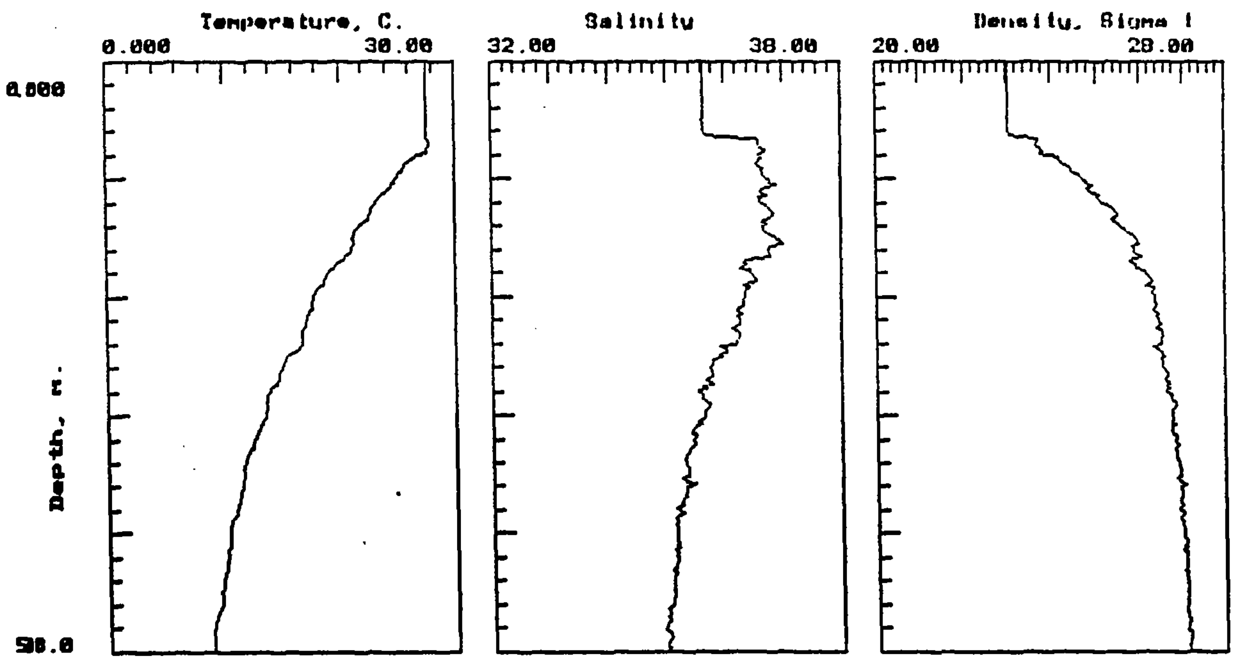

C-103-033



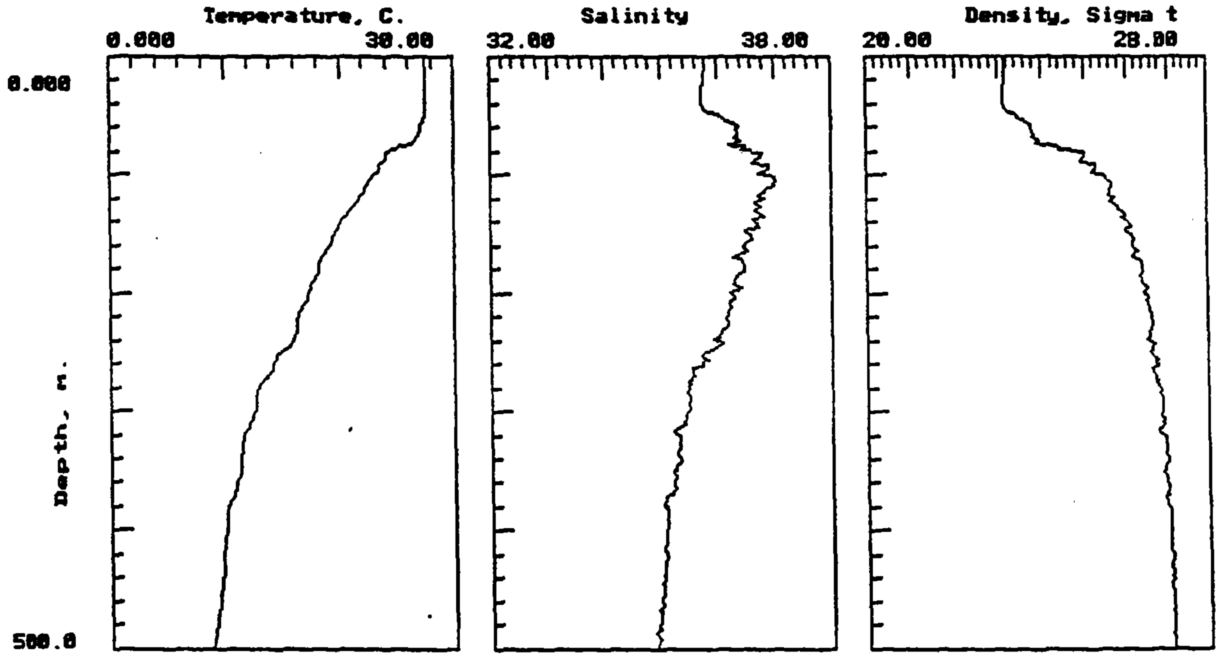

C-103-037



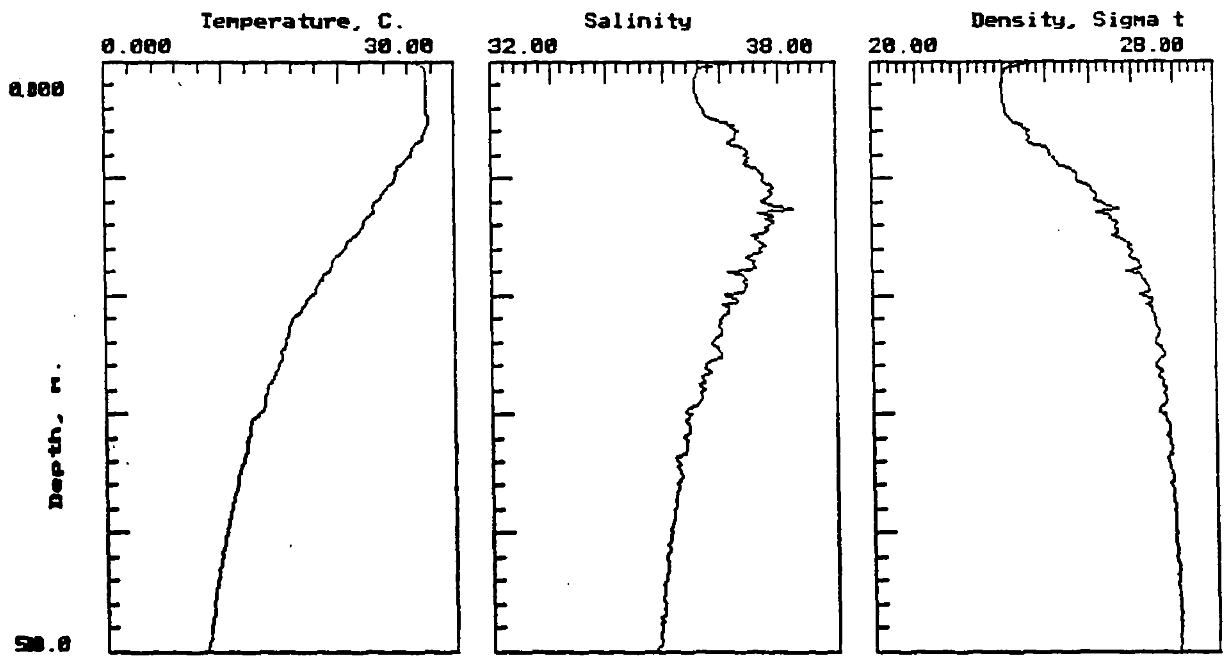

C-103-039



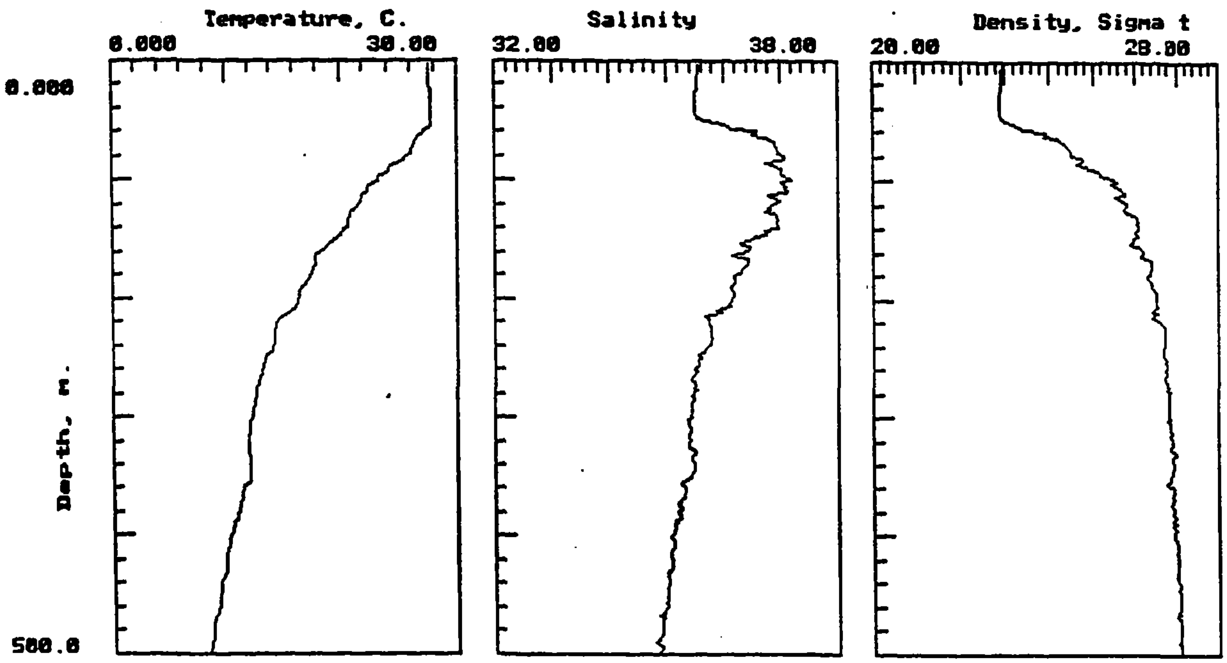

C-103-041



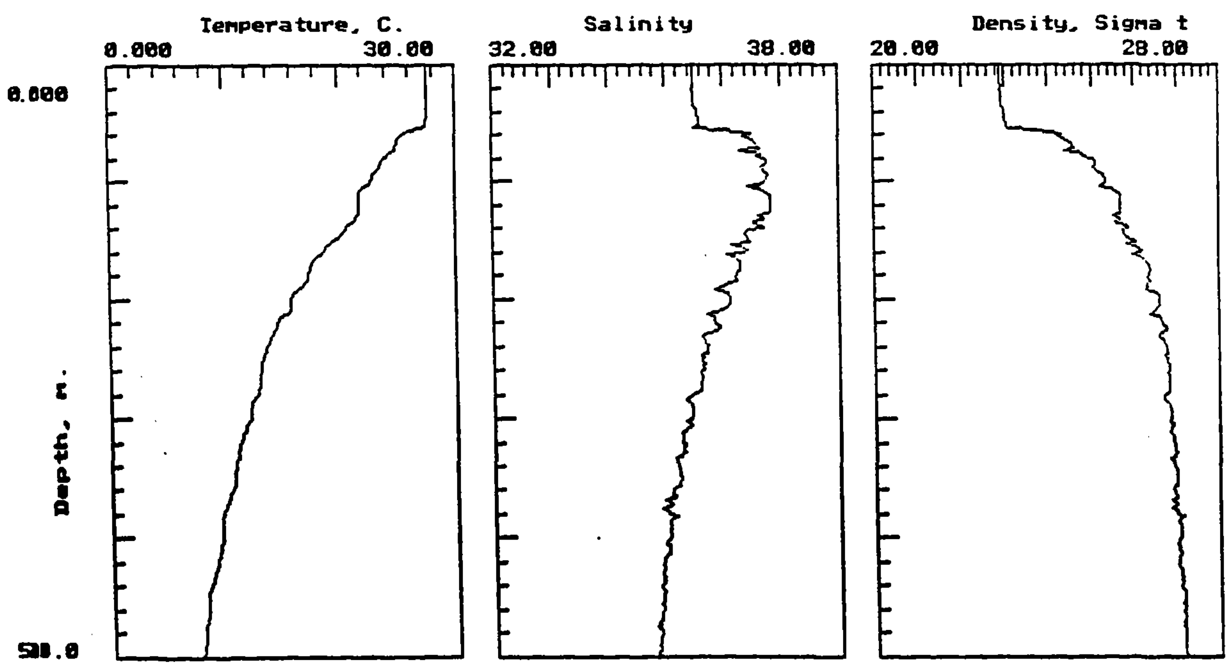

C-103-044



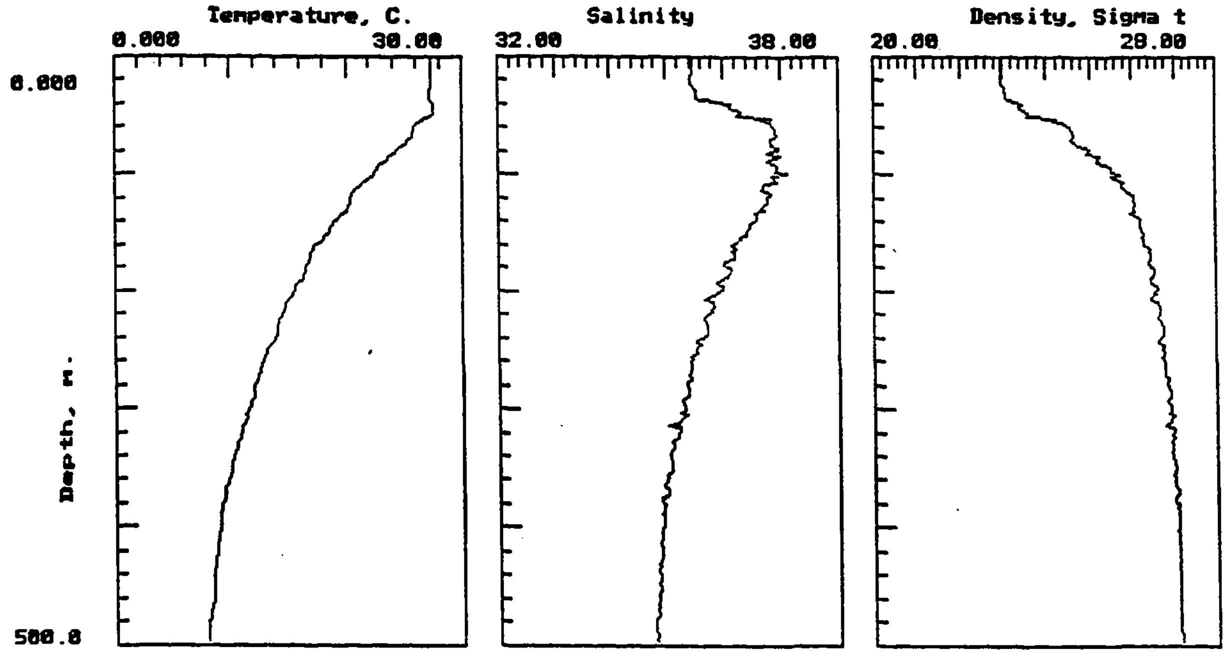

C-103-045



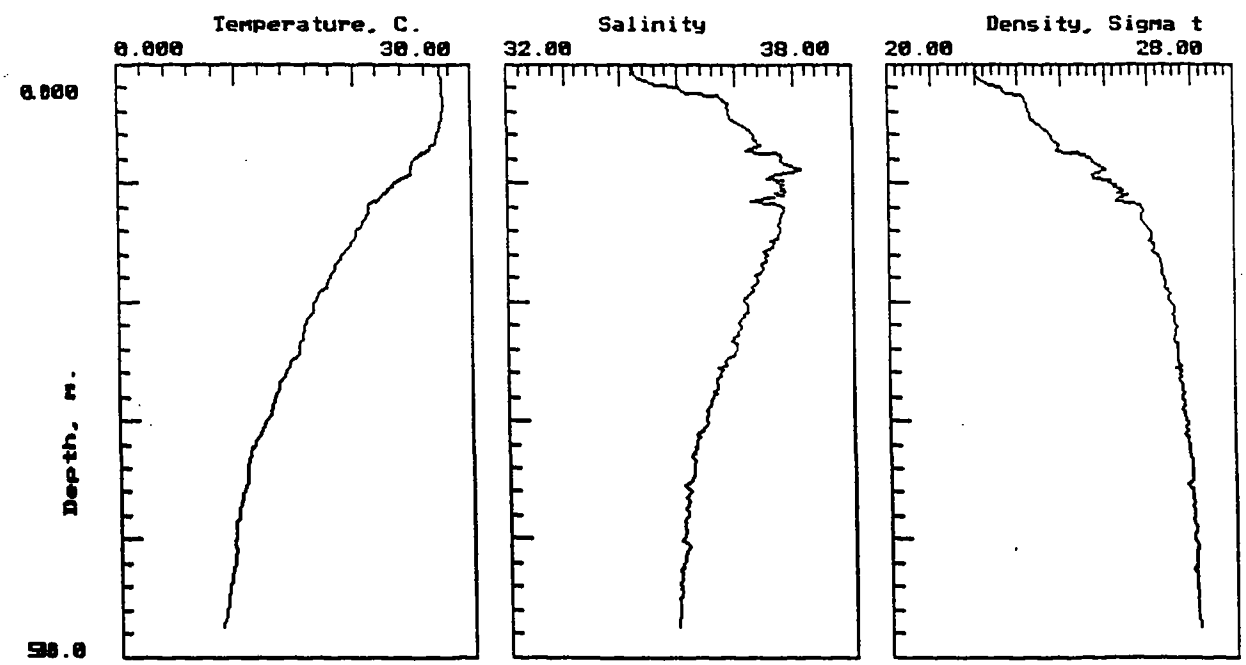

C-103-047



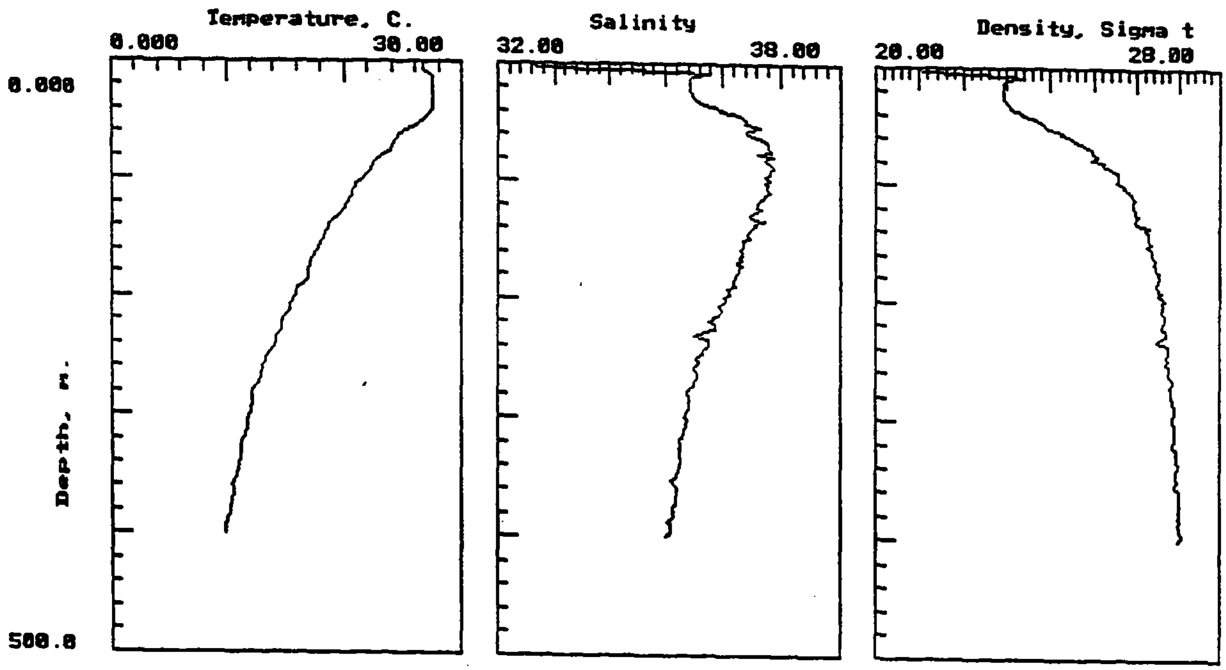

C-103-052



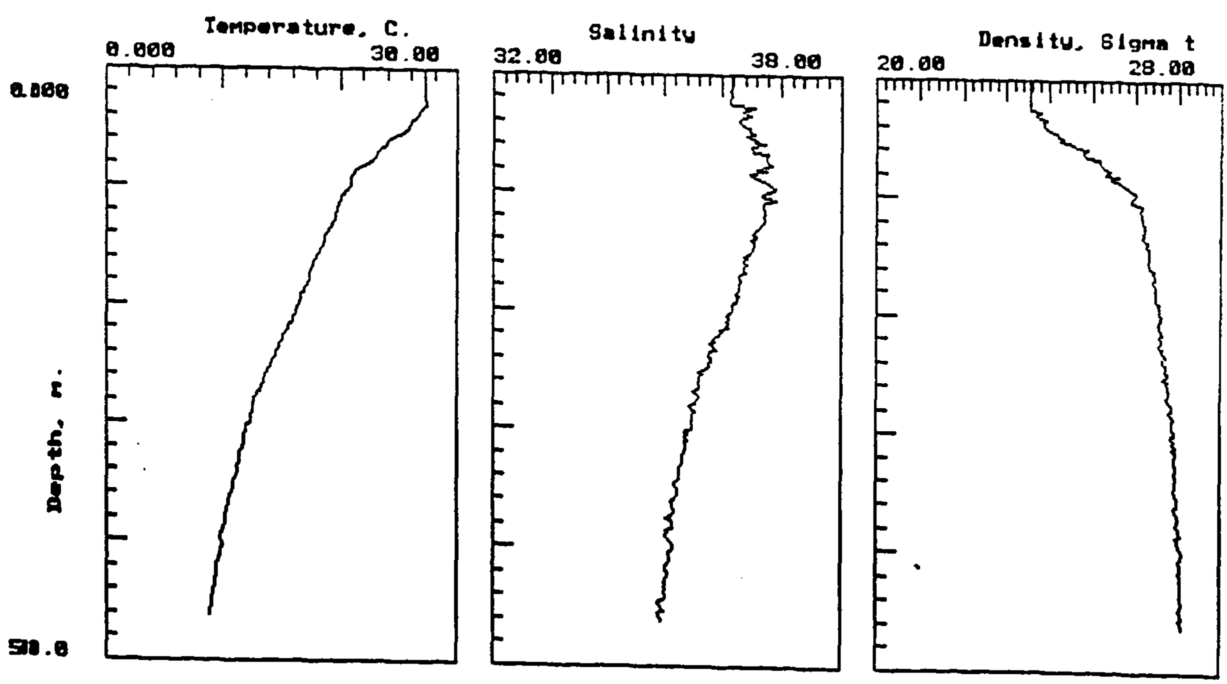

C-103-052



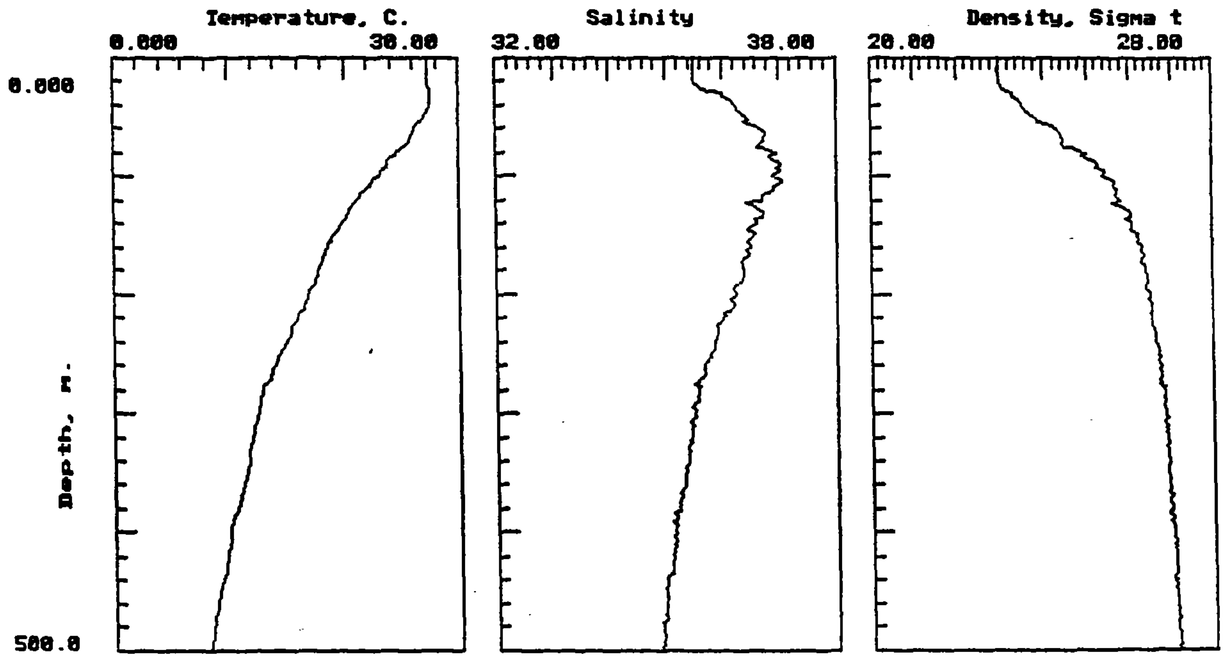

C-103-056



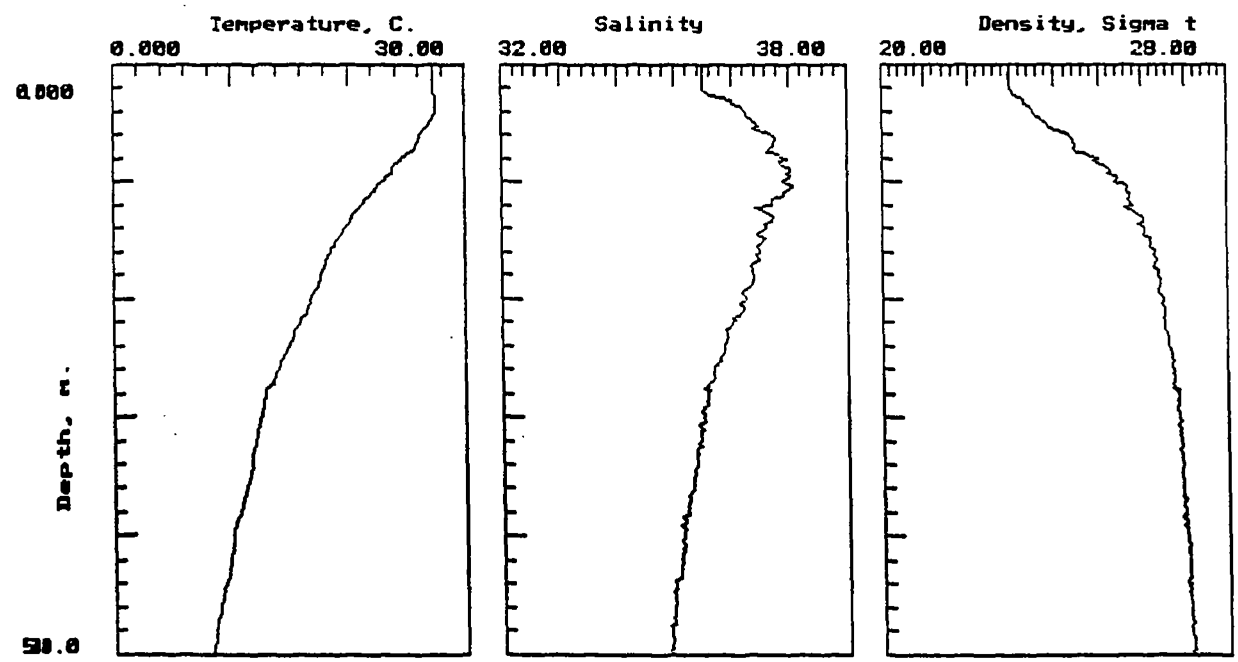

C-103-058



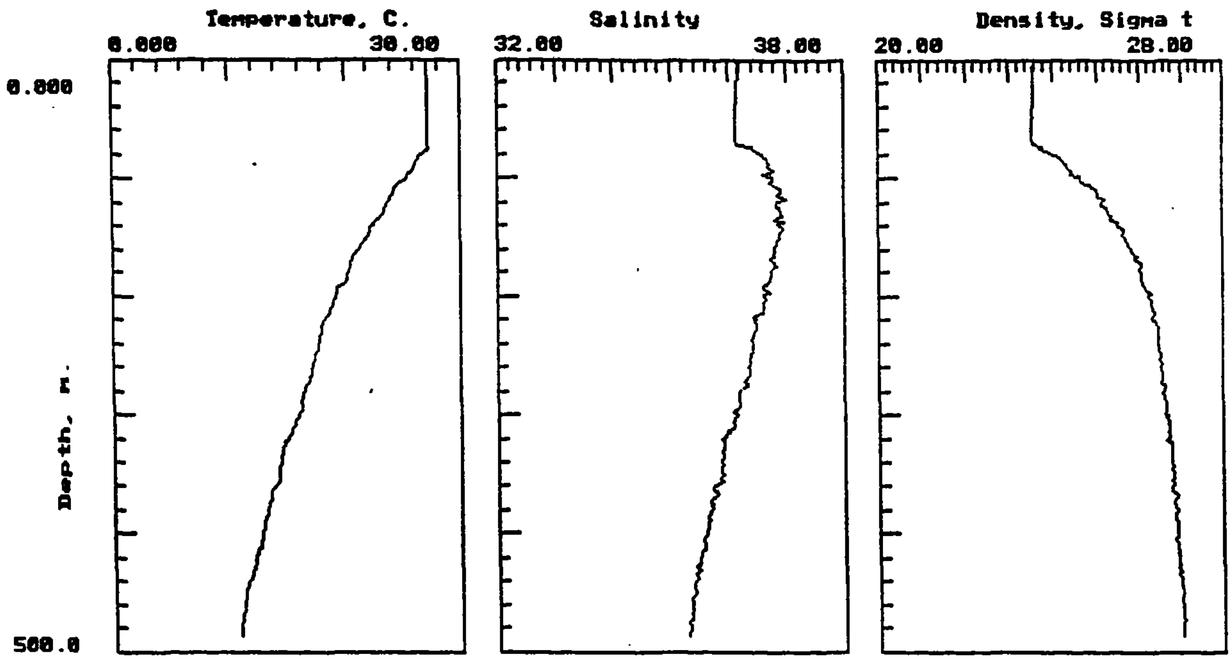

C-103-060



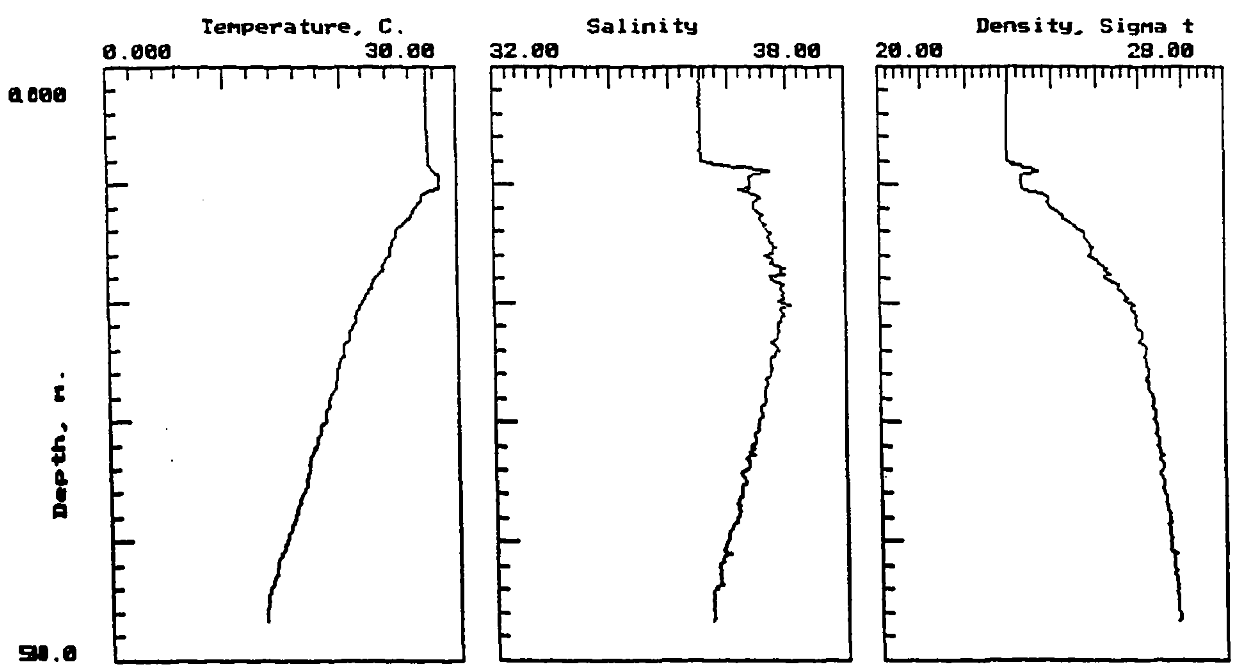

C-103-062



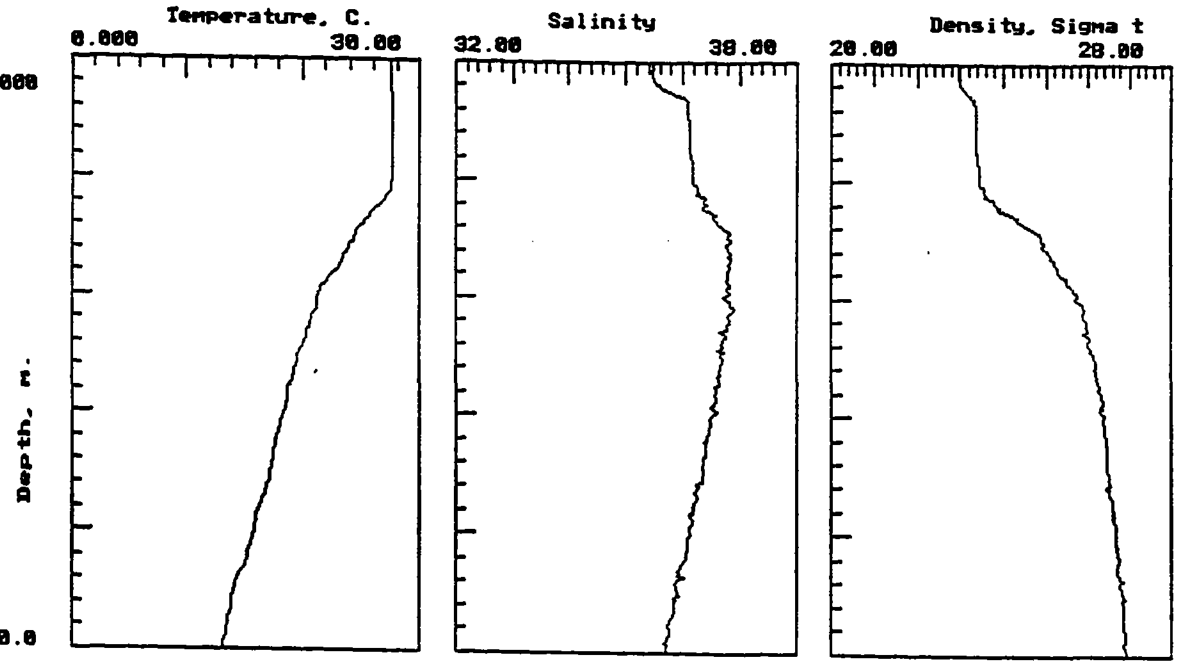

C-103-065



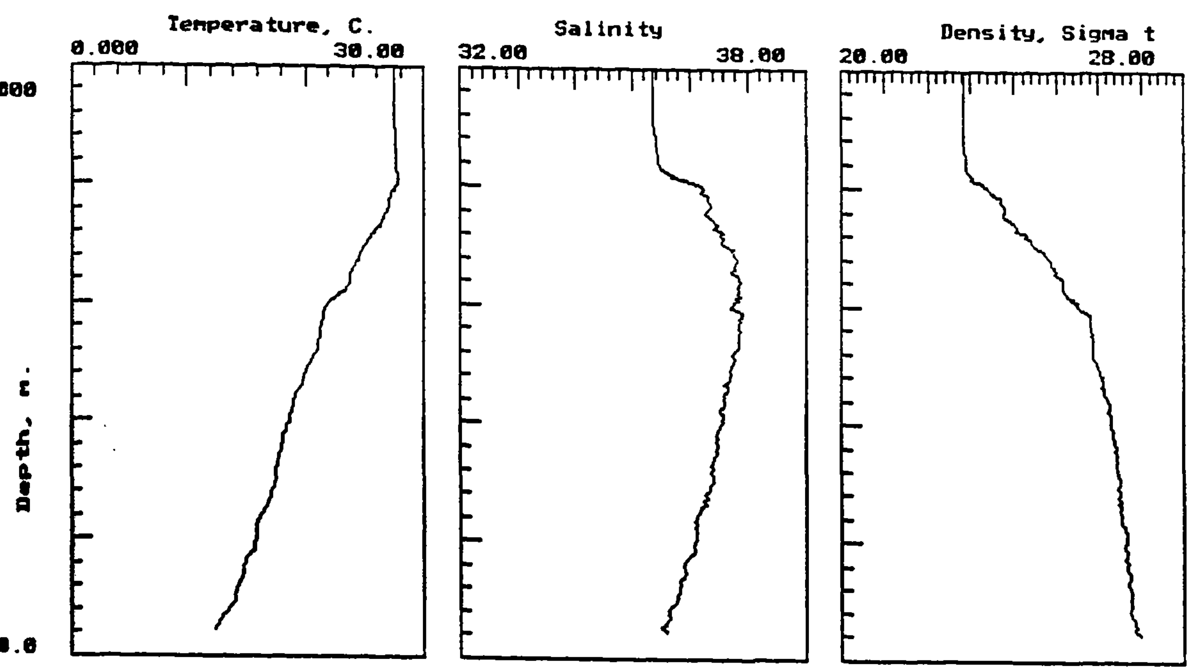

C-103-068



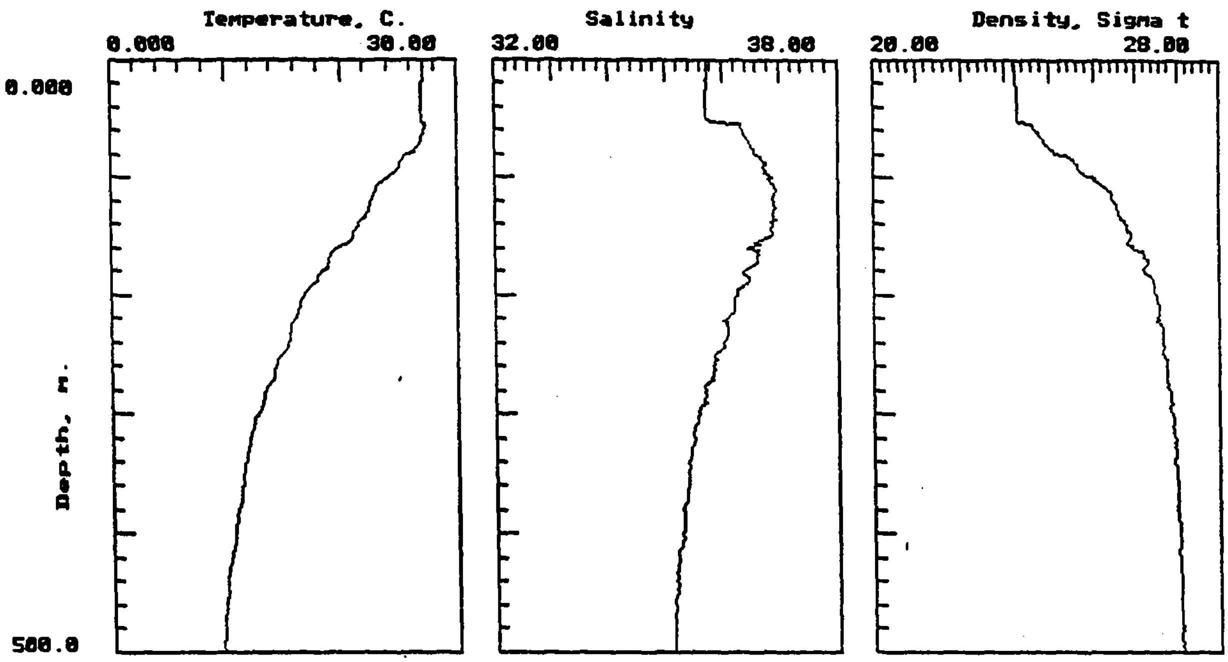

C-103-070



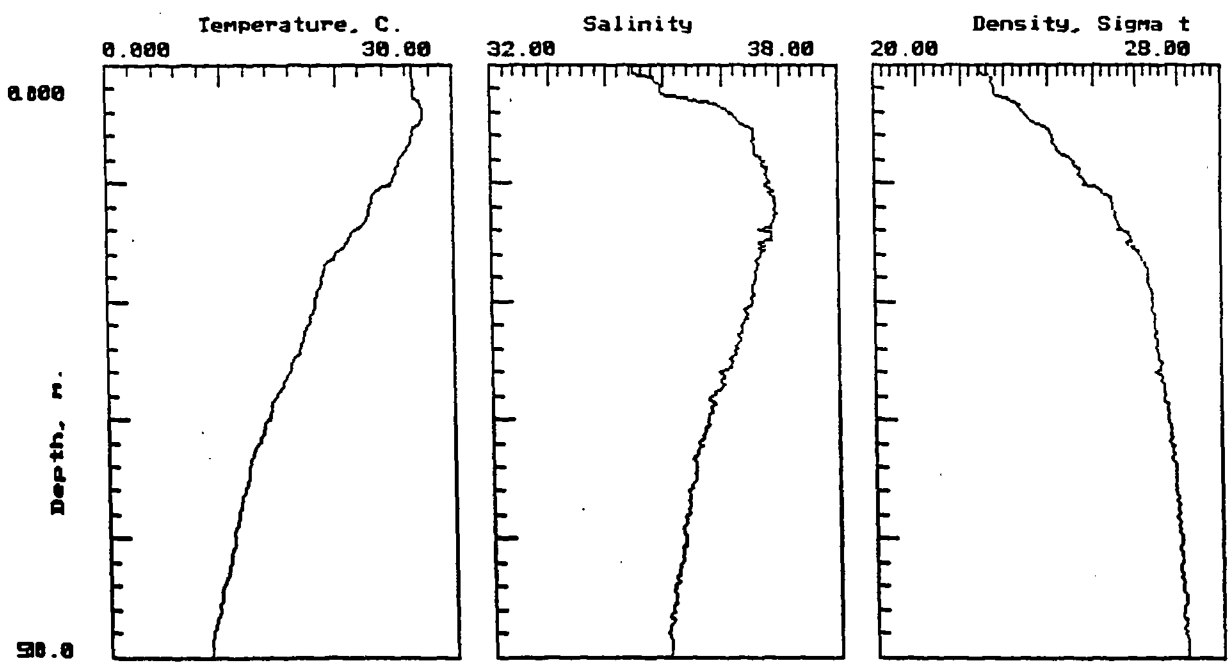

C-103-072



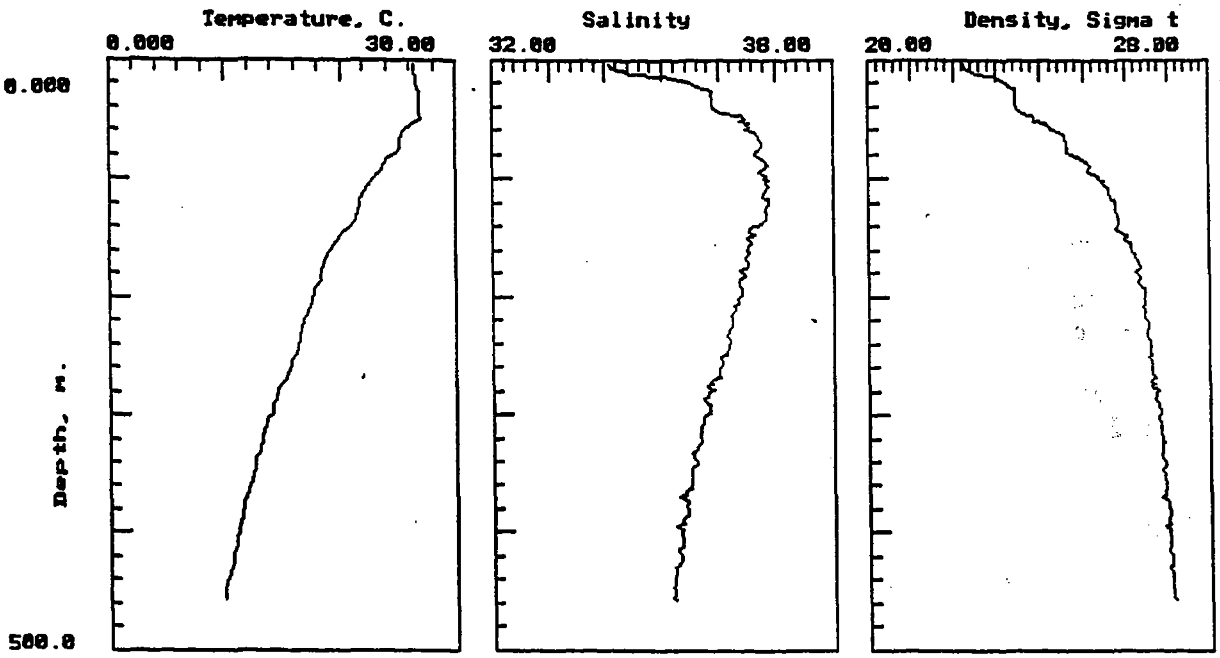

C-103-074



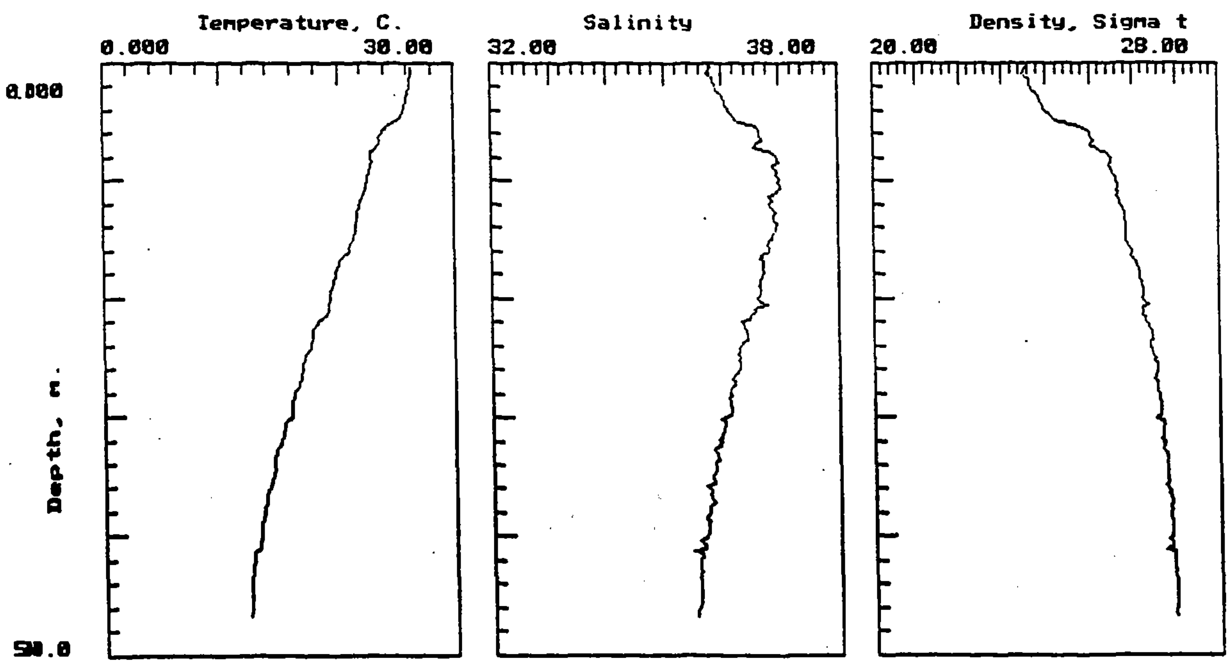

C-103-096




C-103-098




C-103-099




C-103-105

## 4.7 Appendix G - Marine Insect Poetry

*Halobates micans*, oh how you can dance
   o'er trough and crest,
   doth you get no rest?
You're found all over the ocean blue,
   nothing makes you go nowhere, only you.
Not currents, wind, waves or air,
   only your hairy legs get you there.
You can swim two knots, and that's lots
   for a little velvet creature
   that I had to feature.
*Halobates micans*, you put me in a trance,
   I counted more than a grand,
   but do I understand. . .
You're being where you are?
Do you travel far?
   of course, the whole Atlantic Sea
   but where is it you want to be?
Its not with the *Sargassum* weed,
   perhaps its because you need . . .
   to escape the predators that may hide there,
   or since its not food, you just don't care.
Also, its not the salinity amount
   so too much salt can't knock you out.
However, I did find that your food is key,
   and that is where you'd rather be.
For the nymph, the values are not as high,
   but they do eat and therefore do get by.
There's quite a relation between density and adult,
   its them who know the best result . . .
   for food will be, well you can see,
   that adults need more, at least it shows in the score.
*Halobates micans*, why can't you dance
   away from the tows of the night
   for they catch you with delight.
In contrast with the day . . .
   when you seem to slip away . . .
      quite frequently.
So in the end, my jittery friends
   I still don't know where you breed.
It may be tar, plastics, feathers or wood,
   but the quantity measuring devices are just no good.
I can't add them up, their values differ,
   but hopefully, someday the answer you'll deliver.
Yes *Halobates*, I think you shans,
   after all, you are the only *micans*.

D.N., Jan. 7, 1989

## 4.8 Appendix H - C-103 Christmas Carols

OH NEUSTON TOW
(to Jingle Bells)

Crashing through the waves
in a two mast brigantine
Having ice cream craves
but feeling kind of green

Science in the lab
Elvis shining bright
What fun it is to be on watch
at 3:00 o'clock at night

Chorus: Oh Neuston tow, Neuston tows
Science all the time
We'd rather join the *Westward*
for a swizzle with a lime

(repeat chorus)

Saw you weeks ago
aft in our blue wake
Oh the wind did blow
making you so faint.

Looking through the scopes
we talk by radio
Let's try and meet in Roatan
if you're not too slow.

Chorus: Oh Neuston tow, Neuston tows
Science all the time
We'd rather join the *Westward*
for a swizzle with a lime

(repeat chorus)

Merry Christmas
December 25, 1988